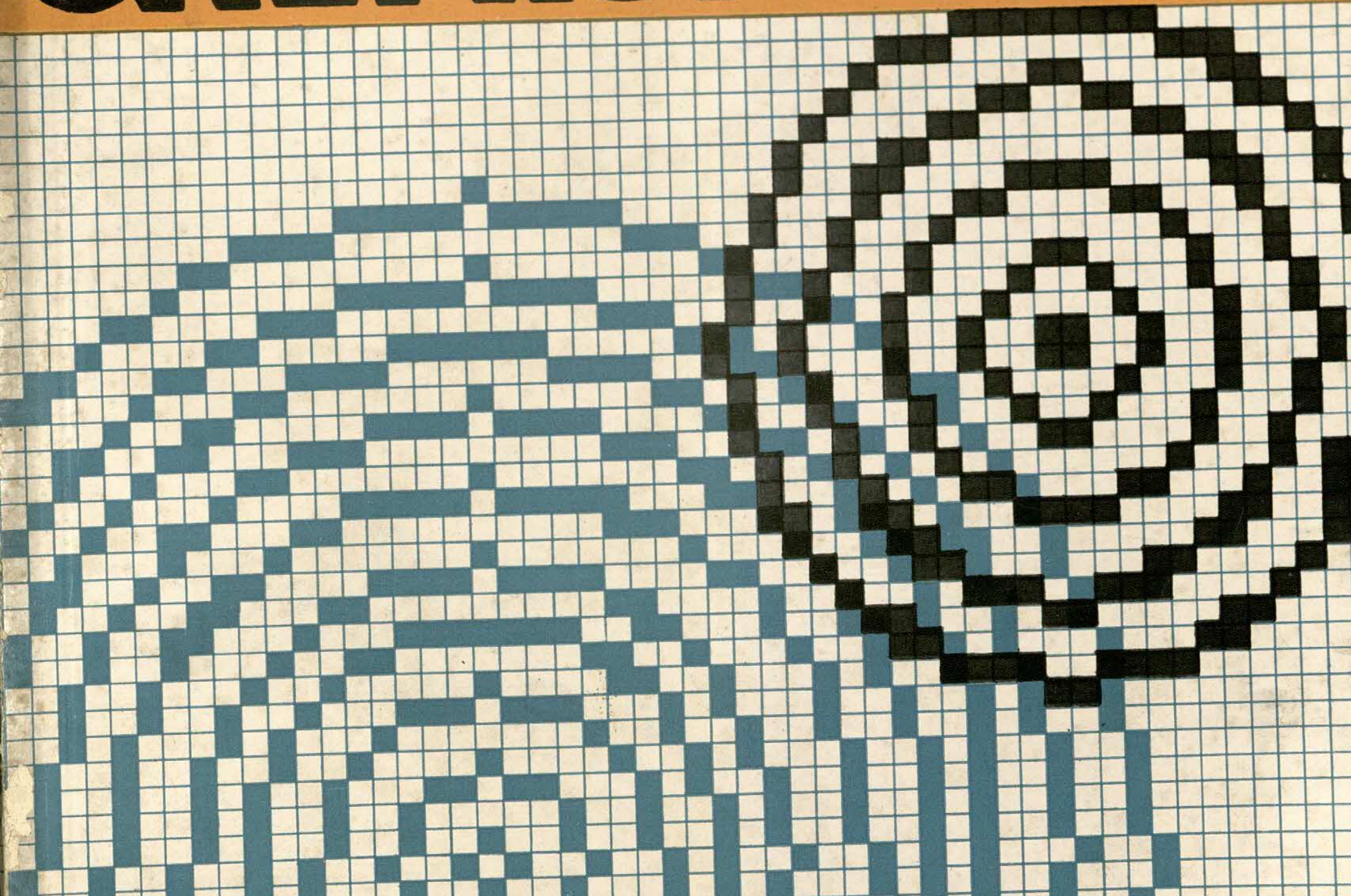
Understanding Science

CHEMISTRY

Class VI



Reena Koshy • D.N. Varma • Vijayalakshmy Srivatsan

Understanding Science
CHEMISTRY

1

Reena Koshy
St. Xavier's School
Delhi

D N Varma
The Doon School
Dehradun

Editor

Vijayalakshmy Srivatsan
Vice Principal
P S Senior Secondary School
Madras

Distributed by
Orient Longman

Understanding Science — Chemistry 1

© 1986 Sangam Books (India) Pvt. Ltd.
First published 1986
Reprinted 1988, 1989, 1990
ISBN 0 86131 650 9

Published by Sangam Books (India) Pvt. Ltd.
3-5-820 Hyderguda, Hyderabad 500 029 (A.P.)

Distributed by
Orient Longman Limited
BOMBAY CALCUTTA MADRAS NEW DELHI
BANGALORE HYDERABAD PATNA GUWAHATI LUCKNOW

ACC NO- 15613

Cover design by The Art Dimension

Design & Layout: Rajesh Gupta for bukprint
H-5/9, Krishna Nagar
Delhi 110 051

Printed in India at
Taj Press
3024 Gali Ahiran,
B.G. Road, Delhi 110 006

Preface

The study of Chemistry is considered an endless memorization of innumerable chemical facts. It places very little emphasis on the most enjoyable part of the subject, experimentation, which really develops the manipulative and intellectual skills of students. The chemical principles grow out of careful observations of chemical changes and this attitude should be developed in students right from the beginning.

This series of three books is directed to achieve these aims. The students are encouraged to develop the habit of questioning and understanding, rather than being satisfied with blind acceptance of facts. At the end of this course students should be able to appreciate scientific methods.

The topics have been chosen according to the requirements of the syllabus laid down by the NCERT. We are certain that the approach will generate interest among the students for the study of the subject.

A large number of experiments and illustrative diagrams have been incorporated to help a better appreciation of the subject. The workbook portion at the end of each chapter will enable the students to assess their understanding of each topic.

November 1986

REENA KOSHY
D N VARMA
VIJAYALAKSHMY SRIVATSAN

Contents

Preface iii

1. **What is Chemistry? 1**
   - The Development of Chemistry
   - Chemistry Laboratory and Apparatus
   - Precautions
   - *Exercises*

2. **Materials around Us 10**
   - Solids
   - Liquids
   - Gases
   - Matter
   - Melting Point and Freezing Point
   - Boiling Point and Condensation Point
   - Evaporation
   - Sublimation
   - Molecules and Atoms
   - Properties of Matter
   - *Exercises*

3. **Physical and Chemical Changes 17**
   - *Exercises*

4. **Mixtures, Compounds and Elements 22**
   - Mixture
   - Compounds and Elements
   - Mixtures and Compounds — A Comparison
   - *Exercises*

5. **Separation of Mixtures into Pure Substances 30**
   - Separation of Solids in a Mixture
   - Separation of Mixture Containing Liquids and Gases
   - *Exercises*

6. **Water 39**
   - Occurrence and Usefulness of Water
   - The Water Cycle
   - Water in Nature
   - Town Water Supply
   - Hard and Soft Water
   - Distilled Water
   - Pollution of Water
   - *Exercises*

7. **The Air Around Us 47**
   - Burning of Air
   - Burning of Magnesium in Air
   - Change of Mass During Burning
   - Water Vapour in Air
   - Carbon Dioxide in Air
   - Noble Gases
   - Carbon Dioxide in Exhaled Air
   - Uses of Gases in Air other than Oxygen
   - Pollution of Air
   - *Exercises*

1

What is Chemistry?

All around us are numerous substances. Many of them undergo changes. Iron rusts; paint peels; logs burn; petrol runs a car; seeds grow into plants, flowers and fruits; milk turns to curd; food gets digested to grow tissues and give energy, etc. We grow up,we grow old. Living plants and animals undergo continuous changes. Even dead plants and animals continue to change as they decay.

When we study these changes carefully, we notice that the changes take place under specific conditions. Iron rusts only in presence of moisture; plants grow only in presence of sunlight; logs burn only when dry. We also notice that in all these cases, the changes are permanent. The old substance turns into a new substance.

The science dealing with the study of substances and the changes they undergo in different conditions is called **Chemistry.**

1.1 The Development of Chemistry

Changes can take place in many substances when they combine with other substances. In history of science, we read about many new substances created accidently while mixing common substances. In 1824 an Englishman—Joseph Aspidin—was mixing limestone and clay. Some water accidently fell into it. In a few hours the mixture turned into a hard, stone-like substance. This led to the discovery of cement.

Another scientist, named Sabatier, changed liquid oil to solid fat. He passed hydrogen gas through liquid oil in presence of a metal named nickel, while heating the oil. On cooling, the oil turned into a white solid substance. Thus 'margarine' or 'vanaspati ghee' was discovered.

Knowledge of the behaviour of substances under different conditions has been made available to us by scientists over the centuries. With this knowledge, chemists have created many new and useful substances from common substances. Glass, which is an object of daily use, is not a natural substance. It is produced by heating a mixture of sand, soda ash and limestone. Another common substance—

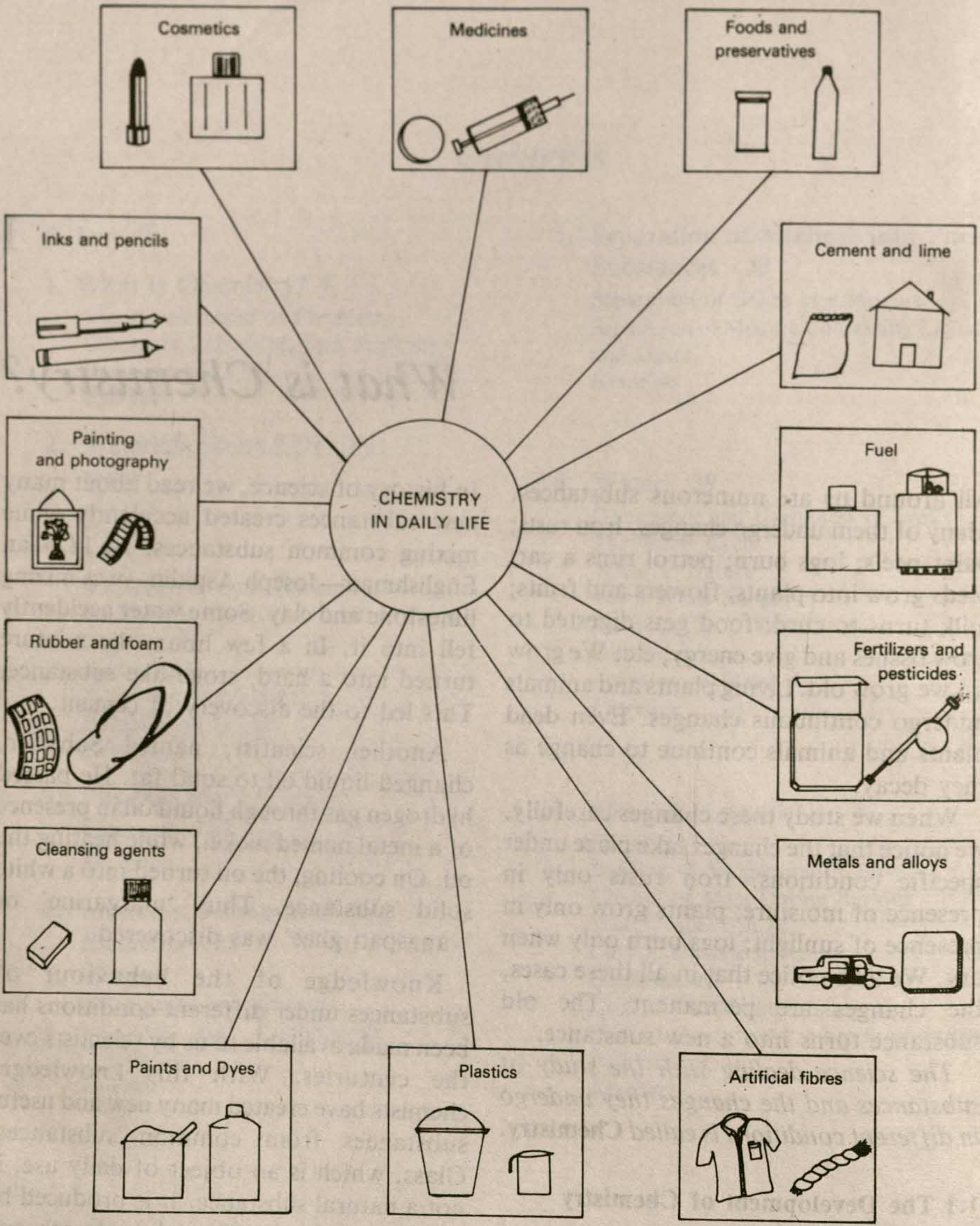


Fig. 1.1 Chemistry in the service of man

rubber—is a natural product taken from the rubber tree. But during times of shortage of rubber, chemists produced artificial rubber from a mixture of petroleum, materials taken from coal and alcohol. Thus chemists make new and better substances from already existing ones to suit our needs.

Chemistry plays an important role in our day to day life. Several materials of necessity and comfort are created by chemists through painstaking experiments. These creations are of great importance in this modern world. Some of the common examples are as follows.

Plastics produced by chemical process are used for making various household articles such as buckets, mugs, containers, toys, combs, raincoat etc.

Artificial fibres are made in different forms such as nylon, rayon, cashmilon, polyester, terene etc. These are used in making textiles, wires, nets, ropes, winter clothes, bristles of brushes, and many other items.

Foam and *rubber* are used in producing mattresses, tyres, tubes, erasers, chappals, etc.

Metals and *alloys* are used for making automobiles, aircrafts, rockets, utensils, knives, coins, etc.

Food is transformed into cells, muscles, and bones and also for creating energy to work, through chemical changes in our body. Many food items are preserved for long periods with the help of certain chemicals, called *preservatives.*

Medicines and *drugs* are mostly chemists' creations and are useful for fighting diseases and improving health through nutrition and by stopping the growth of bacteria and viruses.

Fertilisers and *pesticides* help in increasing agricultural production.

Cosmetics and *toilet* items such as soap, talcum powder, perfumes, creams, shampoo, toothpaste are used by us every day.

Thus the knowledge of Chemistry has helped man to create new and varied materials. Many of these help in improving our life styles and in maintaining good health. It is true that many products of chemistry such as explosives, poisons, bombs, poisonous gases, etc. have caused some extent of suffering and damage to mankind. But then, the fault does not lie with chemistry but with the people who decided to put them to wrong use or handle them carelessly.

Chemistry is a fascinating subject. Apart from modernising our lives, chemistry has given a treasure of knowledge to mankind. Through chemical analyses of materials naturally found on the earth and the moon, many new facts have been understood about the origin of the earth and the moon. Also analyses of materials excavated by archeologists have helped in our understanding of the history of man.

1.2 Chemistry Laboratory and Apparatus

The proper place to learn Chemistry is in the laboratory. The most interesting way to learn Chemistry is through observing experiments. Simple experiments can be done by you while others should be shown by your teacher.

It is great fun to do experiments and observe fascinating chemical changes.

Experiments are done with the help of certain tools specially made for use in the laboratory. These tools are called apparatus. The apparatus for handling chemicals are made of glass or porcelain which do not get affected by most chemicals. Let us now familiarise ourselves with some common apparatus.

Test tube (Fig. 1.2): It is a tubular piece of glass apparatus which is easy to handle and is often used to perform a number of experiments. Small quantities of chemicals are taken in test tubes. It is made of hard glass which is able to stand heat without cracking when heated.

Test tube rack (Fig. 1.3): This is a wooden stand used to keep the test tubes. Test tubes containing chemicals are placed in the space provided. Clean test tubes are placed inverted on the wooden fingers. This helps to keep the test tubes dry.

Test tube holder (Fig. 1.4): When we heat some chemicals in a test tube we cannot hold it in our hands. We use a special metallic adjustable frame to hold the test tube firmly. It has a wooden handle which we can safely hold.

Beaker (Fig. 1.5): is a tumbler shaped glass container. It is used for holding larger volumes of liquids than can be held by test tubes. Beakers of different sizes and volumes are available.

Flasks (Fig. 1.6): are also made of glass and

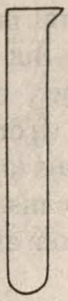


Fig. 1.2 Test tube.

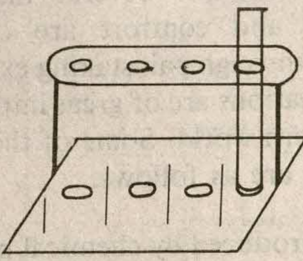


Fig. 1.3 Test tube rack.

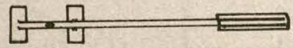


Fig. 1.4 Test tube holder.

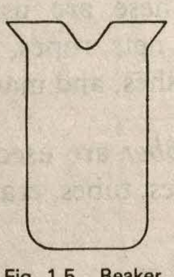


Fig. 1.5 Beaker.

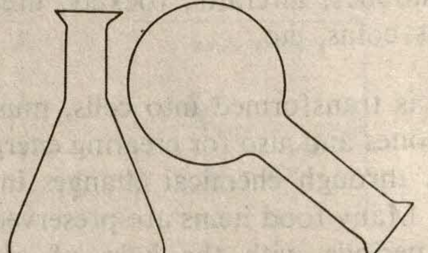


Fig. 1.6 (a) Conical flask. (b) Round flask.

are bigger than beakers. Most common shapes are conical and round.

Funnel (Fig. 1.7): It is used in the laboratory for transferring a liquid from one vessel to another. It is generally made of glass.

Watch glass (Fig. 1.8): is very useful for evaporating small volumes of liquids and for holding small quantities of solids. Watch glass is flat at the bottom.

Evaporating dish or china dish (Fig. 1.9): is made of porcelain. It is specially shaped to help faster evaporation of liquids.

Mortar and pestle (Fig. 1.10): are made of porcelain and are used for powdering solid substances or for mixing two substances thoroughly with each other.

Tripod stand (Fig. 1.11): It is made of iron and is used as a stand for the apparatus. The apparatus to be heated is placed on this.

Gauze (Fig. 1.12): If a beaker or a flask is heated directly by a flame, it may crack. A gauze which is made of iron or steel wires spreads the heat when kept over the flame. The centre of the gauze is coated with asbestos. This prevents the flame from passing through the gauze.

Adjustable stand (Fig. 1.13): Certain apparatus such as a round-bottomed flask need to be supported and held at a convenient height. For this purpose we use an adjustable stand. This stand is made of iron and has a vertical rod fixed to a base. A clamp is mounted on the rod. The clamp holds the flask at its neck. The clamp can

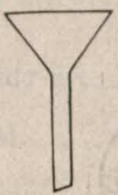


Fig. 1.7′ Funnel.

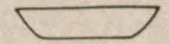


Fig. 1.8 Watch glass.

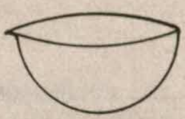


Fig. 1.9 Evaporating or china dish.

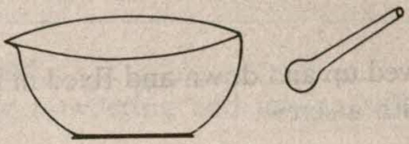


Fig. 1.10 Mortar and pestle.

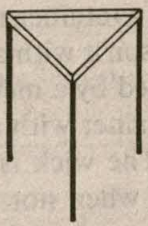


Fig. 1.11 Tripod stand.

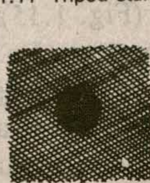


Fig. 1.12 Gauze.

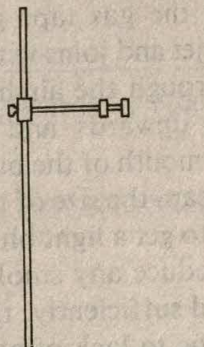


Fig. 1.13 Adjustable stand.

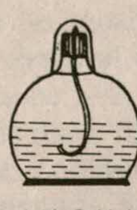


Fig. 1.14 Spirit lamp.

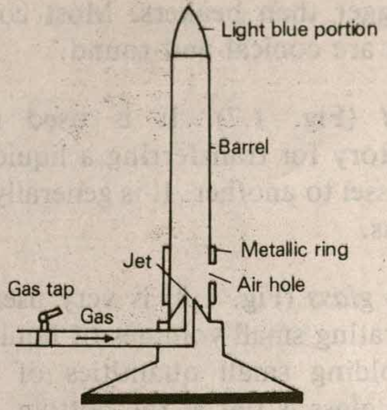


Fig. 1.15 Bunsen burner.

be moved up and down and fixed in position with a screw.

Spirit lamp (Fig. 1.14): is used for heating. It consists of a container made of glass in which we take spirit with a wick in it. The wick is supported by a metal holder at the top of the container with a small opening in the centre. The wick is kept closed by the glass cover when not in use.

Bunsen burner (Fig. 1.15): is a gas burner used in the laboratory. Its principle is very much similar to that of the gas stove in your home. When lighted it is a source of heat and gives a high temperature. At the same time the flame is clean and controllable.

For anything to burn, air is necessary. By opening the gas tap, gas comes out through the jet and joins with the air which comes in through the air hole. This mixture moves upwards and when lighted burns at the mouth of the burner. By moving the ring cap, the size of the air hole can be adjusted to get a light blue flame which does not produce any smoke. If the hole is not opened sufficiently, the gas will not burn fully due to lack of air supply. This flame then becomes yellow and smoky.

1.3 Precautions

For your own and others' safety, there are certain rules to be followed in the laboratory.

Never taste, smell or handle any chemical without your teacher's permission. Some of them are poisonous and injurious to health.

Do not drink water in the laboratory beakers.

While heating a substance in a test tube, hold the test tube tilted and not vertical. In the vertical position, chemicals may spurt on to your fingers. The open end of the test tube should not be turned towards the face of anyone.

While handling chemicals make sure that they *do not come in contact with your skin or clothes.*

Be careful while working with a flame. If anything catches fire, extinguish it by throwing a towel soaked in water or by throwing sand on it. (Towels and sand are usually kept in chemistry laboratories.) *Never try to blow the flame off.*

Always clean the apparatus and table before you leave the lab.

EXERCISES

1. Name the following:

(a) Two changes that we observe in our daily life.________________

(b) One condition necessary for iron to rust.________________

(c) One essential condition for plants to grow.________________

(d) Two new substances which were created from common substances.________

(e) Two artificial fibres.________________

(f) Two items made of plastics.________________

(g) Two chemical products harmful to mankind.________________

(h) The apparatus used in the laboratory for powdering and mixing solid substances.________________

(i) Two types of flasks used in the laboratory.________________

(j) The apparatus used for transferring a liquid from one vessel to another.

____

2. Fill in the blanks:

(a) Utensils and coins are made of________________ and________________.

(b) Cashmilon is an ________________ ________________.

(c) ________________ preserve food items for a long period of time.

(d) ________________ and ________________ help in increasing agricultural production.

(e) ________________ and ________________ are used for evaporating liquids in the laboratory.

(f) The centre of the wire gauze is coated with ________________

(g) ________________ is used for keeping the apparatus at convenient heights.

(h) ________________ and ________________ are two sources of heat used in the laboratory.

(i) Never ________________, ________________ or ________________ any chemical in the laboratory.

(j) Do not ________________ ________________ in the laboratory beakers.

3. Answer briefly:

(a) What is Chemistry? ____________________

(b) What happens to the food we eat? ____________________

(c) What precautions should one take while heating a chemical in a test tube?

(d) How does chemistry contribute to the knowledge of mankind? __________

(e) What is the advantage of using a wire gauze while heating an apparatus on a tripod stand? ____________________

(f) What happens if the hole of the bunsen burner is not opened sufficiently?

(g) What are artificial fibres used for? ____________________

____

____

____

(h) How and by whom was cement discovered? ____________________

____

____

____

(i) Why is there an air hole in a bunsen burner? Is there such an air hole in the gas burner you have at home? ____________________

____

____

____

(j) Draw a diagram of the apparatus you would set up to boil water in a round-bottomed flask. ____________________

____

____

____

2

Materials around Us

Activity 1: Hold a piece of ice in your palm. Slowly it starts melting and turns into water. Collect this water in a small beaker. Heat the beaker for some time. You will notice that water starts boiling and changes into steam. Slowly the water reduces in quantity. Close the vessel with a thin lid. Now you will find that the lid moves slightly up and down. Turn off the flame and allow the vessel to cool. When you remove the lid, you will observe drops of water sticking to the side of the lid facing the vessel. Keep the vessel with water in the freezer of a refrigerator. You will find that the water turns into ice again. Let us now try to understand the science behind these changes.

2.1 Solids

The piece of ice was a firm substance which you could hold between your fingers. It had

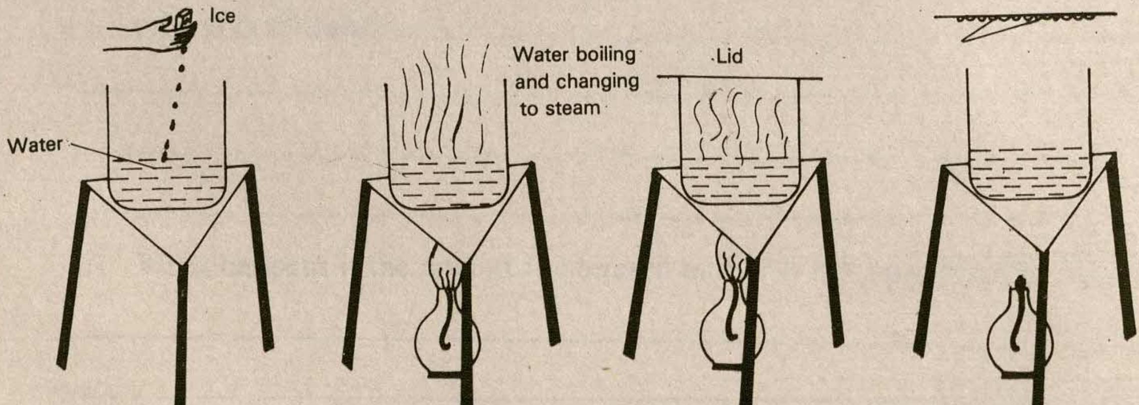


Fig. 2.1

a definite shape and size until the melting started. Many other common substances around us such as wood, stone, knife, coins, etc. also have a definite size and shape. Such materials are called **solids.**

2.2 Liquids

Does water have a definite size or shape? Let us look at some other common substances such as milk, oil, juice, petrol, etc. These substances require a vessel to hold, and adjust to the shape of the vessel. When we transfer such substances from one vessel to another, the shape changes according to the vessel (Fig. 2.2). When kept on a flat surface, these substances tend to spread and cover a larger area. Such materials are called **liquids.**

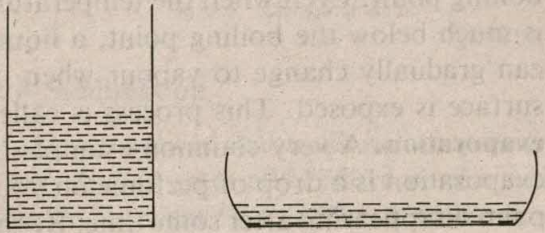

(a) Liquid in a glass (b) Liquid in a bowl

Fig. 2.2 Liquids do not have definite shape

2.3 Gases

When water is boiled, its quantity slowly reduces. Wet clothes hung out in the sun slowly dry up. Where does the water go? There is a third category of materials which do not have a size or shape, and cannot even be seen in most cases. We can sense their presence by feeling the pressure or by smell in some cases. When we blow into a balloon, it gets inflated. Using a pump you can fill air into your cycle tyre. While sitting under the fan you feel the pressure of air. When there is a leak from the cooking gas cylinder you sense it because of the smell of the gas. Can you name some more similar substances? Carbon dioxide, oxygen, nitrogen, chlorine are some examples. These substances can be compressed to fit into a small container or can expand to occupy a large container or even a whole room. Thus these materials do not have any definite size, shape or volume. *They will acquire the volume of the container as well as its shape.* We call these materials **gases** or **vapours.** Vapour is the gaseous form of a substance which is normally a liquid, e.g. petrol vapour or water vapour.

2.4 Matter

All these materials—solids, liquids and gases—occupy space and have a definite weight. They are collectively called **matter.** *We define matter as anything which has volume and weight.* Matter can exist in any of the three forms—solid, liquid, or gas. These three forms are called **physical states** of matter.

Change of matter from one form to another—solid to liquid, liquid to gas, and vice versa—is known as **change of state.** We notice that water exists as a solid in the freezer of a refrigerator where the temperature is below 0°C; as liquid when the temperature is between 0°C and 100°C; and as gas or vapour when the temperature is above 100°C. Hence we realise that state of matter depends on the temperature.

$$\text{Solids} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftarrows}} \text{Liquids} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftarrows}} \text{Gases (vapour)}$$

2.5 Melting Point and Freezing Point

Activity 2: Heat wax in a beaker. It starts melting and after some time becomes liquid wax. Using a thermometer measure the temperature at which melting starts. Allow all the wax to melt and then cool it. It gradually turns into solid wax. Again measure the temperature at which liquid wax starts changing to solid. You will notice that wax melts from solid to liquid and solidifies from liquid to solid at *exactly the same temperature.* The temperature at which a solid changes to liquid is known as its **melting point** (M.P.). Similarly the temperature at which a liquid changes to solid is called its **freezing point.** Obviously the melting point and the freezing point of a particular substance are the same.

Materials which are liquids at room temperature have generally low melting points. All materials which are solids at room temperature will melt if the temperature is raised sufficiently.

2.6 Boiling Point and Condensation Point

When we heat water continuously for some time, we notice that water boils and steam is produced. The temperature at which a liquid boils and turns into vapour form is called its **boiling point (B.P.).**

If the vapour is allowed to cool it turns back into liquid form. This process is called **condensation** and the temperature at which it takes place is called the **condensation point.** Boiling point and condensation point of a substance are the same. Ordinary gases such as carbon dioxide, oxygen, nitrogen etc. can also be changed to liquid form if cooled sufficiently.

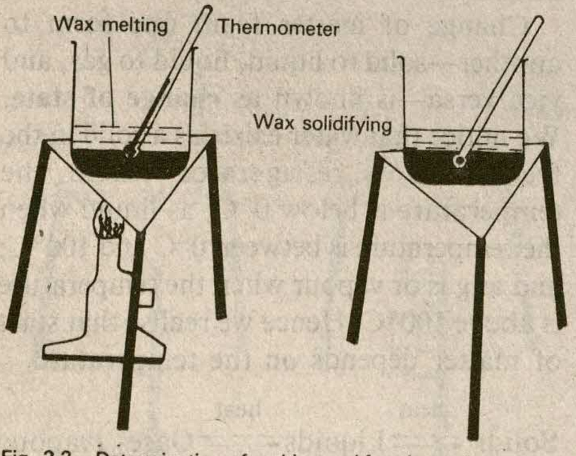


Fig. 2.3 Determination of melting and freezing points of wax.

2.7 Evaporation

Change of a liquid to vapour state need not take place only when it is heated to its boiling point. Even when the temperature is much below the boiling point, a liquid can gradually change to vapour when its surface is exposed. This process is called **evaporation.** A very common example of evaporation is a drop of perfume on your palm disappearing after some time. By the process of evaporation we dry wet clothes. You must have noticed that on a warm day wet clothes dry very fast. If in addition to being warm, it is windy as well, the clothes dry even faster. This shows that the process of evaporation is faster in presence of heat and wind.

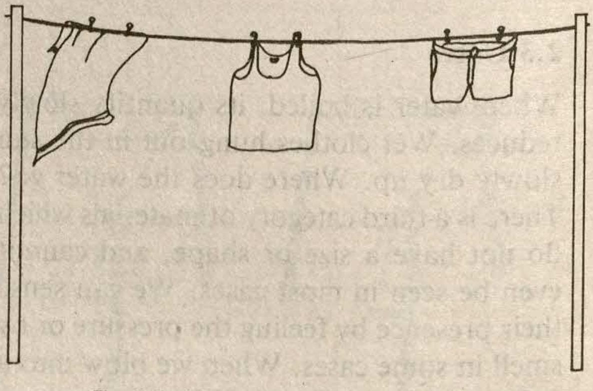


Fig. 2.4 Wet clothes dry up in the sun..

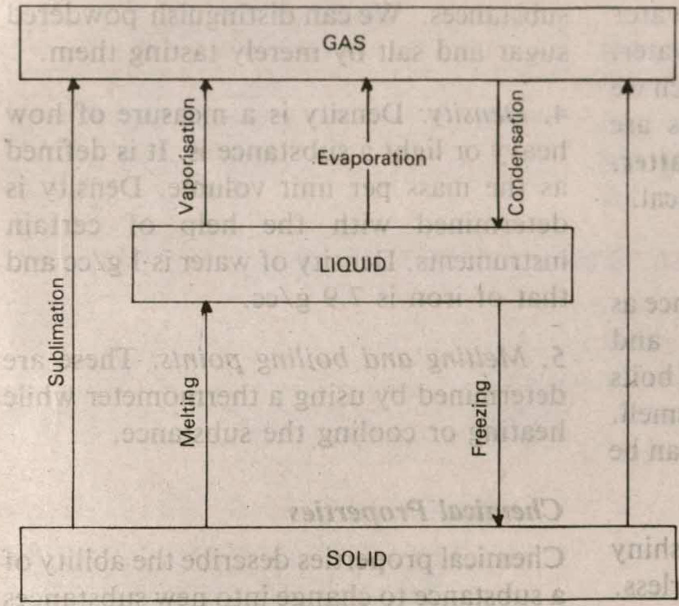


Fig. 2.5 Change of state.

2.8 Sublimation

Have you noticed that moth balls kept with your clothes gradually reduce in size and finally disappear? You will not notice any trace of liquid where the mothball is kept. Actually the mothball changes directly to gaseous form. Other examples of solid materials changing directly to gaseous form are 'Vicks' inhaler, 'Odonil' air freshner; camphor; iodine etc. The process of a solid changing directly to gas without becoming a liquid is known as **sublimation.** Such solids are called **sublimates.**

2.9 Molecules and Atoms

What does matter consist of? Matter is built up of extremely tiny particles which are invisible even when viewed through a microscope. These particles are called **molecules.** The arrangement of molecules decide the physical state of matter. In solids, molecules are very closely packed in an orderly manner. In liquids molecules are less closely packed and in gases molecules exist far apart. In one class of solids the closely packed molecules arrange themselves in a definite pattern giving special shape to the solid. Such solids are called **crystalline solids.** Sugar is a crystalline solid. You can observe cubical **crystals** of sugar.

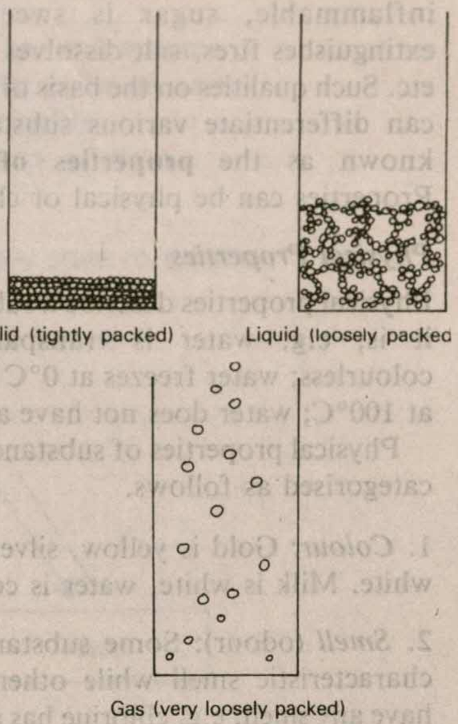


Fig. 2.6 Arrangement of molecules in solids, liquids and gases.

A scientist named John Dalton discovered that a molecule itself is made up of still smaller particles called **atoms.** We will study more about molecules and atoms in later chapters.

2.10 Properties of Matter

We distinguish one form of matter from another by some qualities. Water is transparent, milk is white, petrol is inflammable, sugar is sweet, water extinguishes fires, salt dissolves in water, etc. Such qualities on the basis of which we can differentiate various substances are known as the **properties of matter.** Properties can be physical or chemical.

Physical Properties

Physical properties describe a substance as it is, e.g. water is transparent and colourless; water freezes at 0°C and boils at 100°C; water does not have any smell.

Physical properties of substances can be categorised as follows.

1. *Colour:* Gold is yellow, silver is shiny white. Milk is white, water is colourless.

2. *Smell* (odour): Some substances have characteristic smell while others do not have any smell; e.g. chlorine has a pungent smell, oxygen has no smell at all, petrol has a specific odour. Smelling of substances should be done very cautiously because some of them could be injurious to health.

3. *Taste:* We taste only such substances which are edible but not unknown substances. We can distinguish powdered sugar and salt by merely tasting them.

4. *Density:* Density is a measure of how heavy or light a substance is. It is defined as the mass per unit volume. Density is determined with the help of certain instruments. Density of water is 1 g/cc and that of iron is 7.9 g/cc.

5. *Melting and boiling points:* These are determined by using a thermometer while heating or cooling the substance.

Chemical Properties

Chemical properties describe the ability of a substance to change into new substances under different conditions, e.g. iron changes to rust in the presence of oxygen and moisture; milk turns to curd; coal burns to produce smoke, ash etc.

Chemical properties cannot be easily categorised. This is because numerous changes take place in different substances under different conditions. While studying about different substances later we will deal with their specific chemical properties.

EXERCISES

1. Mark the following statements as true or false.
   (a) Melting point and boiling point of a substance are the same.
   (b) The shape of a liquid changes according to the shape of the container.
   (c) Molecules are the smallest particles of a substance.
   (d) Water exists as a solid above 100°C.
   (e) In gases molecules are very loosely packed.

2. Match the following:

(i)	John Dalton	(a)	mass per unit volume
(ii)	Copper	(b)	freezing point of water
(iii)	Density	(c)	inflammable
(iv)	Petrol	(d)	discovery of atom
(v)	O°C	(e)	is a solid

3. In Fig. 2.7 write the process of change from one state to another.

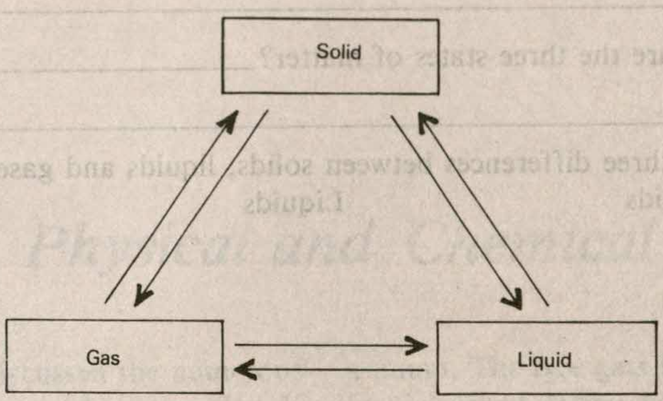


Fig. 2.7

4. Fill in the blanks.
   (a) When molecules are arranged in a definite pattern in a solid, the solid is said to be ________________.
   (b) The process of changing a solid directly to a gas is known as________.
   (c) By the process of ________________________ wet clothes dry up.
   (d) ________________ and ________________ are two sublimates.
   (e) ________________ is the smallest particle of a substance.
   (f) The temperature at which a liquid boils and changes to vapour is known as ________________
   (g) We measure the temperature of a substance using a ____________

5. Define the following terms:
   (a) Matter ____

   ____

   (b) Melting point ____

   ____

(c) Vapour ____

____

6. Answer the following questions:

(a) Name the major physical properties of matter. ____________________

____

____

(b) What are the three states of matter? ____________________

____

(c) Write three differences between solids, liquids and gases.

	Solids	Liquids	Gases
1.			
2.			
3.			

7. Classify the following substances as solids, liquids or gases.
Kerosene, hydrogen, petrol, milk, chlorine, lime juice, ice, stone, paper, carbon dioxide, sugar, nitrogen.

Solids: ____

Liquids: ____

Gases: ____

3

Physical and Chemical Changes

We have already discussed the numerous changes that occur around us, everyday. If you study these changes closely, you will find that they can be grouped into two types of changes. Let us carry out some experiments and observe the results before grouping the changes.

Activity 1: Press the switch of an electric bulb. The filament in the bulb glows white hot, emitting light and heat. Now switch it off. The bulb stops glowing and returns to its original condition (Fig. 3.1.).

Activity 2: Inflate your bicycle tyre using a pump. The tyre gets filled with air and gets hardened. If you disconnect the pump and release the valve, the tyre deflates, becoming soft again (Fig. 3.2).

Activity 3: Put a teaspoon of salt in half a beaker of water and stir. The salt disappears completely. Now heat the salt water till the water evaporates completely. You will see that a white substance—salt—is left in the vessel (Fig. 3.3).

Activity 4: Light a piece of paper using a matchstick and allow it to burn. The burning produces heat, smoke and light. When

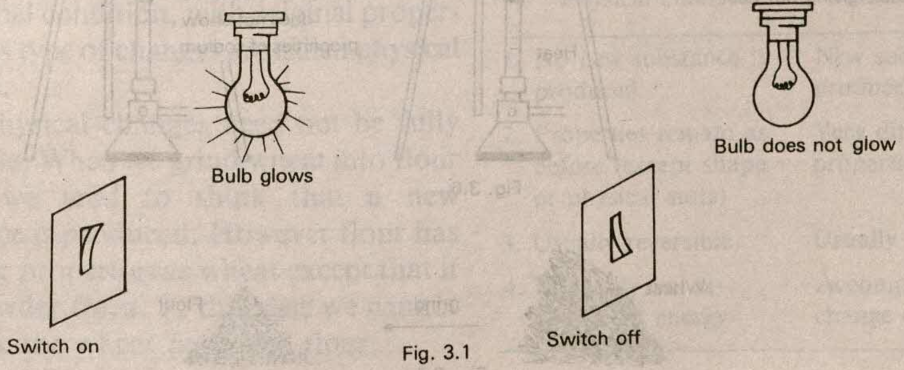


Fig. 3.1

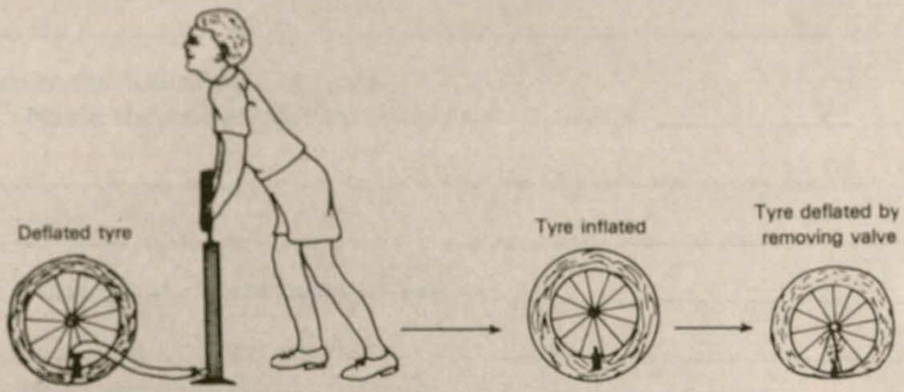

Deflated tyre
Tyre inflated
Tyre deflated by removing valve

Fig. 3.2

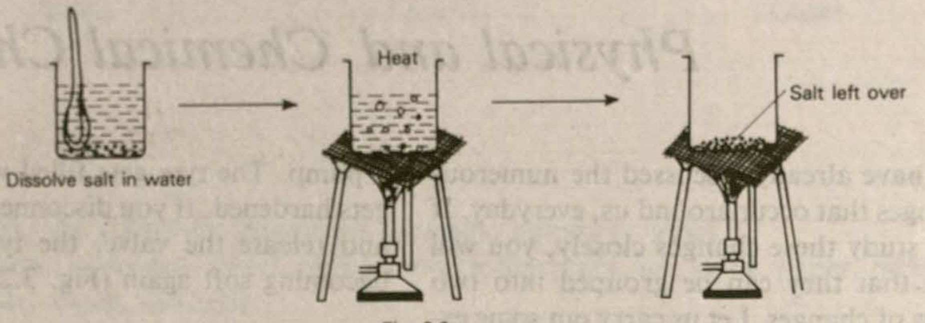


Fig. 3.3

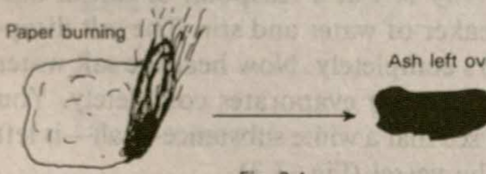


Fig. 3.4

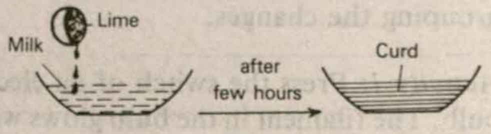


Fig. 3.5

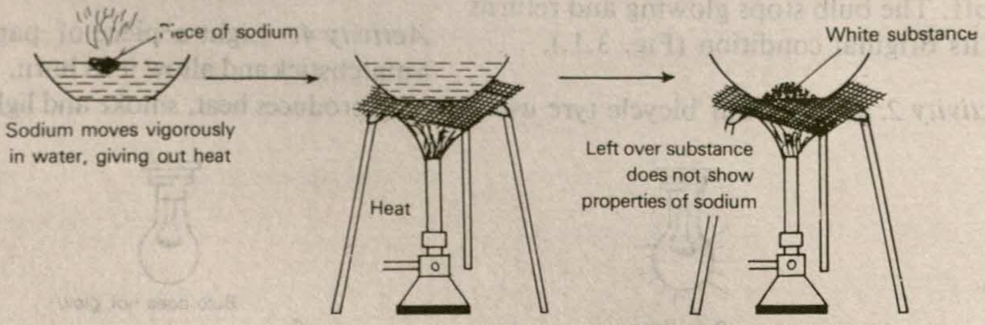

Piece of sodium
Sodium moves vigorously in water, giving out heat
Heat
White substance
Left over substance does not show properties of sodium

Fig. 3.6

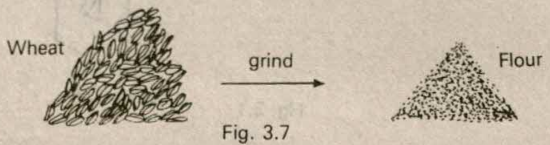


Fig. 3.7

the burning is complete ash is left behind, which is very different in appearance and properties from the original paper (Fig. 3.4).

Activity 5: Take some milk in a bowl and add a few drops of lime juice to it. Leave it undisturbed for a few hours. You will find that the milk has turned into curd, a thicker sour substance, white in colour but very different from milk (Fig. 3.5).

Activity 6: Put a small piece of sodium into a large beaker containing water. Sodium moves vigorously in water with a hissing sound and emits smoke, heat and light (Fig 3.6). Finally it disappears completely. Now heat this water and allow it to evaporate completely. You find that a white substance is left behind. If you put this substance into water it dissolves quietly, without any of the behaviour you noticed when sodium was put into water.

Let us now discuss the changes that took place in these experiments. In the first three experiments, we notice that there are changes in the form or in the physical state of the substances. But no new substances are produced. We also notice that the process of change is easily reversible. That is we are able to get back the substance into its original condition, with original properties. This type of changes are called **physical changes.**

All physical changes need not be fully reversible. When we grind wheat into flour (atta), we tend to think that a new substance is produced. However flour has the same properties as wheat except that it is in powder form. In this case we cannot get back the wheat from the flour.

In activities 4 to 6 we observe that one substance changes into another. The new substance formed shows properties entirely different from those of the original substance. Also the process is not reversible—ash cannot be changed back to paper and curd cannot be changed back to milk. Such type of changes are known as **chemical changes.**

The most important difference between chemical and physical changes is the formation or non-formation of a *new substance exhibiting different properties.* There is another difference too between chemical and physical changes. A chemical change is associated with exchange of energy e.g. burning of paper produces heat and light, digestion of food produces energy in our body.

Exchange of energy takes place in some physical changes also, e.g. lighting of bulb produces heat and light. But it must be remembered that exchange of energy not associated with change of properties will not be a chemical change.

We will now summarise the differences between physical and chemical changes.

Table 3.1

Differences between Physical and Chemical Changes

Physical change	*Chemcial change*
1. No new substance is produced	New substances produced
2. Properties remain as before (except shape or physical state)	Very different properties
3. Usually reversible	Usually irreversible
4. Generally no exchange of energy	Accompanied by exchange of energy.

EXERCISES

1. Which of the following changes are physical and which are chemical? Write in the space provided.
   - (a) Dissolving sugar in tea. ________________
   - (b) Ringing of an electric bell. ________________
   - (c) Chopping of wood. ________________
   - (d) Melting of wax. ________________
   - (e) Burning of candle. ________________
   - (f) Rusting of iron. ________________
   - (g) Drying of wet clothes. ________________
   - (h) Burning of a cigarette. ________________
   - (i) Glowing of an electric heater. ________________

2. In a pressure kerosene stove, we pump kerosene and convert it to kerosene vapour and then light it. The vapour catches fire. State which of these is a physical change and which is a chemical change? ________________

   ____

   ____

3. Write true or false.
   - (a) Chemical changes are generally accompanied by exchange of energy.
   - (b) A chemical change is usually reversible.
   - (c) The disappearance of sugar when it dissolves in water is a physical change.
   - (d) A new substance is always produced in a chemical change.
   - (e) When an electric heater is switched on it gives out heat. It is a chemical change.

4. What is the most important difference between physical and chemical changes? Write two other differences between the two changes. ________________

   ____

   ____

   ____

   ____

   ____

5. Indicate clearly whether the following processes are physical or chemical, giving reasons in each case.

(a) The addition of sodium in water. ________________

____

____

____

(b) The addition of sodium chloride (common salt) in water. ________________

____

____

____

15613

4

Mixtures, Compounds and Elements

You are already familiar with the three states of matter—solids, liquids and gases. All known substances exist in one physical state or another at a particular temperature. You have also seen that matter is made up of molecules. Matter exists in different states due to difference in molecular arrangements.

Matter can be divided into three kinds—**mixtures, compounds** and **elements.** These three kinds of matter can exist in any of the three physical states.

4.1 Mixture

Activity 1: Take some water in a beaker. Add a teaspoon of salt and some sand to it. Stir to dissolve the salt. In case you live near a sea shore, you can get some sea water in the beaker instead.

Examine the water carefully. You will find grains of sand in this water. Use a piece of cloth to filter the sand particles. If you taste the water you will find that it is salty. Heat the water until it completely

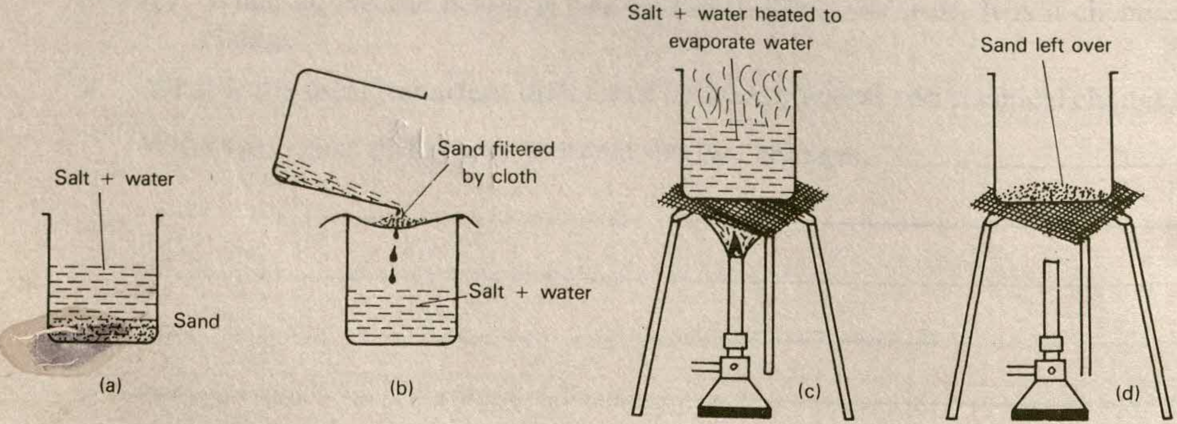


Fig. 4.1 A mixture of sand, salt and water can be separated into its components.

evaporates. The water disappears to vapour form leaving salt behind.

Let us now study some of the properties of this sample of water. We have seen that it is possible to separate out the ingredients or components by simple methods. Also this water shows certain properties of all the components—appearance of ordinary water, taste of salt and grittiness of sand. It is also possible to prepare samples with different ratios of salt and sand in the water. This sample is a **mixture** of water, salt and sand.

Mixture may be defined as *a substance which is formed by the combination of two or more different substances, exhibiting average properties of each of the components.*

From the properties mentioned above it is clear that mixture formation is always a physical change.

Many substances we come across in our daily life are mixtures. Milk is a mixture of fat, sugar, protein, water etc. Drinking soda is a mixture of carbon dioxide and water. Air is a mixture of nitrogen, oxygen, carbon dioxide, water vapour, etc. Common mixtures we prepare at home are lemonade, icecreams, etc.

Solution

In a mixture of water and sand, water and sand are separately visible. However there are some mixtures where the components are not separately visible. These mixtures therefore appear to be a single substance e.g. salt water, or milk and water. These are called **solutions.** In other words *a solution is a uniform mixture of two or more substances.*

A solution always contains two parts.

(1) *Solute:* A solute is a substance that dissolves in another substance.

(2) *Solvent:* A solvent is a substance which dissolves the solute.

solute + solvent = solution

In salt solution, salt is the solute and water is the solvent.

Solute and solvent can be solids, liquids or gases.

4.2 Compounds and Elements

In the mixture of sea water we discussed earlier, one of the components was salt. What is this substance 'salt' made of? Scientists have found that salt is made up of two substances known as *sodium* and *chlorine.* Sodium is a metal of pale yellow colour and chlorine is a greenish-yellow gas. But the substance formed by the combination of sodium and chlorine is a crystalline white substance. Sodium when put in water produces a hissing sound,

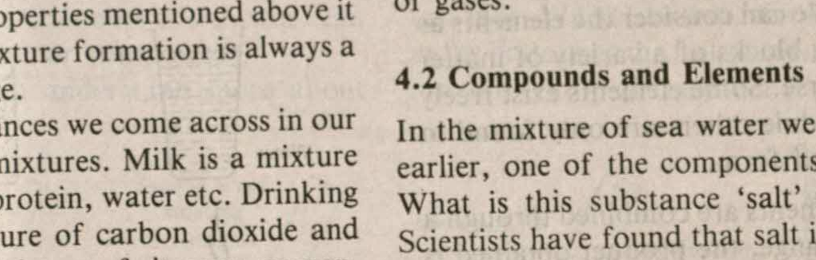


Fig. 4.2 Mixtures around us.

moving vigorously. If touched, sodium causes a burning sensation. Chlorine is a poisonous gas with a pungent smell. But salt, chemically known as sodium chloride, does not have any of these properties. In fact it is a very useful substance essential for our health.

Water is another common substance formed by combining two gases, hydrogen and oxygen. Hydrogen is highly combustible (substance which catches fire easily) and oxygen always supports burning. But water has properties very different from these and in fact puts out fires.

Sodium, chlorine, hydrogen and oxygen discussed above cannot be further divided into different substances. They are the basic units and the simplest form of matter called **elements**. We can consider the elements as the building blocks of a variety of matter in the universe. Some elements exist freely in nature, while others are only found in the combined form.

When elements are combined through a chemical change, the product obtained is a **compound**. Salt and water are compounds. Properties of a compound are entirely different from the properties of the constituent elements. Unlike in mixtures, in a compound the constituent elements are combined in a definite ratio by mass. Thus we may define a compound *as a substance formed by the chemical union of two or more elements in a definite ratio by mass.*

We come across many more elements and compounds in our daily life. Common elements are gold, copper, silver, mercury, oxygen, hydrogen, carbon, sulphur, iron etc. Some of the commonly known compounds and their constituent elements are given in Table 4.1.

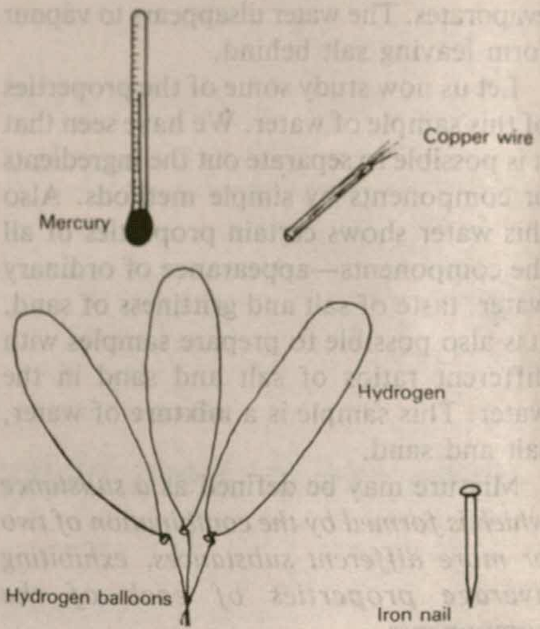


Fig. 4.3 Elements around us.

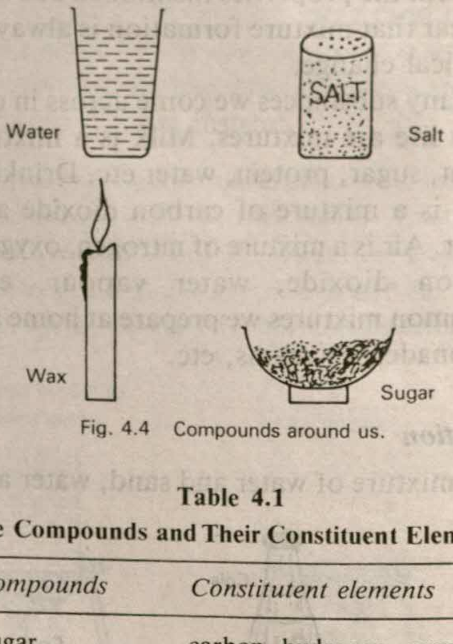


Fig. 4.4 Compounds around us.

Table 4.1

Some Compounds and Their Constituent Elements

Compounds	*Constitutent elements*
1. Sugar	carbon, hydrogen, oxygen
2. Kerosene	carbon, hydrogen
3. Water	hydrogen, oxygen
4. Common salt	sodium, chlorine
5. Spirit	carbon, hydrogen, oxygen
6. Wax	carbon, hydrogen

You will notice that there are many different compounds which have the same constituent elements. For example both spirit and sugar, are formed by the chemical union of carbon, hydrogen and oxygen. These compounds have entirely different physical and chemical properties. They differ in the manner in which these elements combine. You will learn more about it in later chapters.

4.3 Mixtures and Compounds—A Comparison

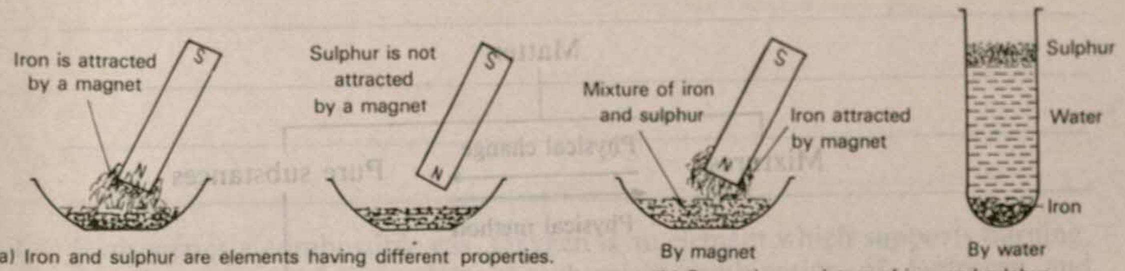
Elements and compounds are generally called *pure substances* because they have definite characteristic properties of their own. On the other hand, mixtures show varying properties depending on the components and the ratio in which they are present. The components of a mixture can be elements and/or compounds.

Let us try to understand more about elements, compounds and mixtures through an experiment.

Activity 2: Take one spoon each of iron filings and sulphur powder. Both are elements with different properties. Iron is a shiny metal, attracted by a magnet and is heavier than sulphur. Sulphur is bright yellow in colour and is not attracted by a magnet. Mix these two together; we get a mixture which has a combination of colours of both iron and sulphur.

Bring a magnet over this mixture. The iron filings get attracted to the magnet leaving the sulphur behind. Thus we can separate the elements from the mixture (Fig. 4.5b).

Another simple method of separation is by putting the mixture in water taken in a test tube. We notice that iron filings settle at the bottom of the test tube while sulphur remains on top of the water (Fig. 4.5b). If

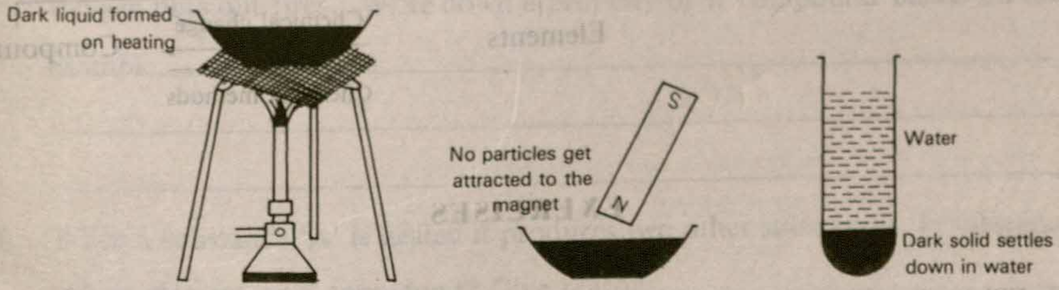

Iron is attracted by a magnet
S
N
Sulphur is not attracted by a magnet
S
N
Mixture of iron and sulphur
S
N
Iron attracted by magnet
Sulphur
Water
Iron

(a) Iron and sulphur are elements having different properties.

By magnet

By water

(b) Separating a mixture of iron and sulphur


Dark liquid formed on heating
No particles get attracted to the magnet
S
N
Water
Dark solid settles down in water

(c) Iron and sulphur, when heated, form a compound.

Fig. 4.5

we carefully filter the contents of the test tube, we can separate iron and sulphur.

Now put the iron filings and sulphur in a china dish and heat the dish with a bunsen burner (Fig. 4.5c). You will notice a thick dark brown liquid being formed. On cooling, it becomes a hard solid of the same colour (Fig. 4.5c). Bring a magnet over the substance produced. You will not find any iron filings getting attracted to the magnet. Now put the substance produced into a test tube containing water. You will find that the whole mass of the substance settles at the bottom of the test tube. This substance is actually a compound of iron and sulphur called *iron sulphide.*

Through this experiment we can understand the main differences in the properties of mixtures and compounds. Let us now try to list them (Table 4.2).

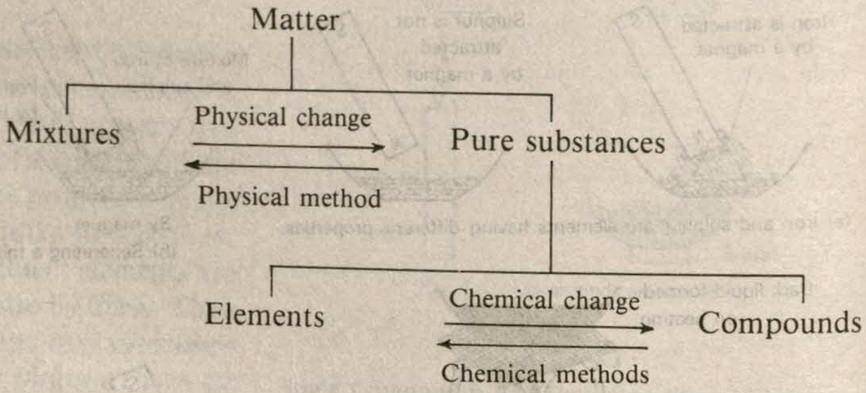
Thus all forms of matter can be classified into elements, compounds and mixtures.

Table 4.2

Differences between Mixtures and Compounds

Mixture	*Compounds*
1. Formed by a physical change.	Formed by a chemical change.
2. Shows average properties of its components.	Shows entirely different properties than that of its constituent elements.
3. Components can be easily separated by physical methods.	Cannot be separated by physical methods but separation possible by certain chemical methods.
4. Components can be put together in any ratio.	Constitutent elements will be always in a definite ratio by mass.

The following chart summarises the relationship between various types of matter.



EXERCISES

1. Fill in the blanks.

(a) ________________ and ________________ are called pure substances.

(b) A compound is formed by the chemical combination of __________.

(c) __________________ is the simplest form of matter.

(d) ____________ and ____________ are two compounds containing the same constituent elements in different ratio.

(e) Iron filings are attracted by a __________________.

(f) Mixture formation is a __________________ change.

(g) Substances formed by the mixing of two or more elements or compounds are called __________________.

(h) Air is a __________________ of gases.

2. Indicate whether the following are mixtures, compounds or elements.

(a) Water ______________

(b) Ice cream ______________

(c) Iron sulphide ______________

(d) Sea water ______________

(e) Gold ______________

(f) Carbon dioxide ______________

(g) Copper ______________

(h) Oxygen ______________

(i) Soda ______________

(j) Sodium chloride ______________

3. Write two differences between elements and compounds. ______________

____

____

____

____

4. Hydrogen is a combustible gas. Oxygen is an element which supports burning. But the compound formed by the chemical combination of hydrogen and oxygen puts out fires. Write down a property of a compound based on this example ____

____

____

5. When a substance 'A' is heated it produces two other substances. Is substance 'A' an element or a compound? Give reasons. ______________

____

6. What kind of material—compound or mixture—is obtained when sugar is dissolved in water? Explain

7. Write down the names of some elements, compounds and mixtures normally existing as solid, liquid, and gas.

	Elements	Compounds	Mixtures
Solid			
Liquid			
Gas			

8. Give three differences between a mixture and a compound.

9. Write true or false.

(a) Matter can exist in only three states.

(b) Two or more elements can form a mixture.

(c) Two or more compounds can form a mixture.

(d) Two or more elements can form a compound.

(e) A solution is a mixture.

(f) A solution must contain a solute and a solvent.

(g) Salt is a mixture.

(h) Water is a mixture.

(i) A physical change is necessary to form a compound.

(j) In a compound the elements can be in any ratio.

(k) In a mixture the components can be in any ratio.

(l) Any two elements can combine to form only one compound.

(m) Solutions are pure substances.

5

Separation of Mixtures into Pure Substances

We come across many substances of use which contain impurities. The river water used for town supply contains many dissolved and floating substances; the milk supplied by the vendor contains water and dust particles, the rice and 'dal' we buy have some stones, sand and husk in them; petrol sometimes is mixed with kerosene; the air in certain localities may contain chemical fumes, smoke and dust. Besides, sometimes we accidently mix substances, for e.g. salt and sugar, or 'dal' and rice. We also hear about some traders mixing cheap and sometimes harmful materials with foodstuffs to increase their profits. Common examples of such adulteration are papaya seeds with pepper seeds, or mashed potatoes and water in milk.

For the sake of our health and good living, it is necessary that impurities are removed to get pure substances from these mixtures. There are a number of methods by which components of a mixture can be separated.

We have already learnt that mixtures are formed by the combination of pure substances (elements and compounds). Since mixture formation is a physical change, we know that this process can be reversed. That is, the components present in a mixture can be separated out by various physical methods. All the methods take advantage of the differences in physical properties of the components. For example to separate a mixture of salt and water we take advantage of the property of water, that it boils and turns into vapour at 100°C.

5.1 Separation of Solids in a Mixture

1. Winnowing

When one of the solids is much lighter than the other, we can blow the lighter part away. This process is known as winnowing and is commonly used by farmers to separate rice or wheat from husk.

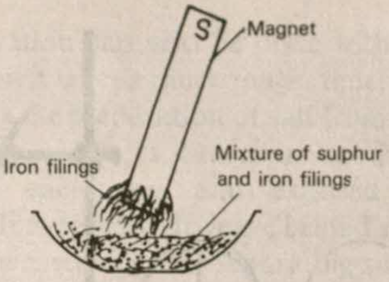


Fig. 5.1 Separation of a mixture of iron filings and sulphur by a magnet.

2. *Sorting*

When one of the solids present is bigger, different in shape or colour than the other, sorting is done by hand picking, or by machine. For example, removal of stone from rice or separation of rock pieces from coal.

3. *By a Magnet*

There are certain elements which are attracted by magnets, e.g. iron and steel. A mixture of a magnetic substance and a non-magnetic substance can be separated by using a magnet. Iron filings and sulphur or steel pins and sand can be separated by this method (Fig. 5.1).

4. *By Sublimation*

If one of the solids present in the mixture is a sublimate the process of sublimation is made use of for the separation. Camphor (sublimate) and common salt, iodine (sublimate) and sand, or ammonium chloride (sublimate) and common salt can be separated by this method.

Activity 1: Put a mixture of ammonium chloride and common salt in a china dish and cover it with a funnel. Block the tip of the funnel by a piece of cotton. Heat the mixture using a burner. The sublimate present in the mixture (ammonium chloride) changes to gaseous form and gets condensed on the cooler sides of the funnel (Fig. 5.2). The non-sublimate component (common salt) will be left behind in the china dish. Scrape out the condensed sublimate from the sides of the funnel.

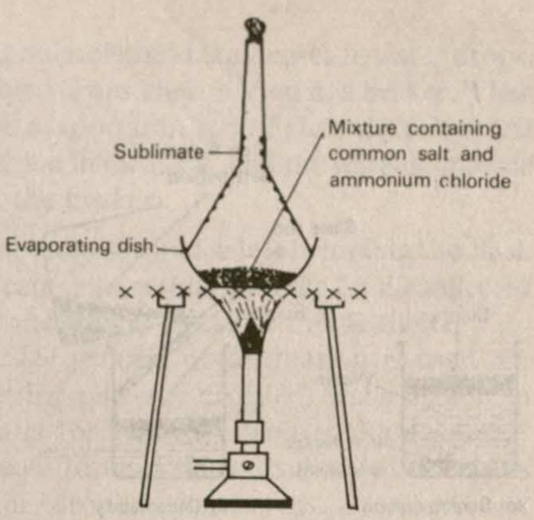


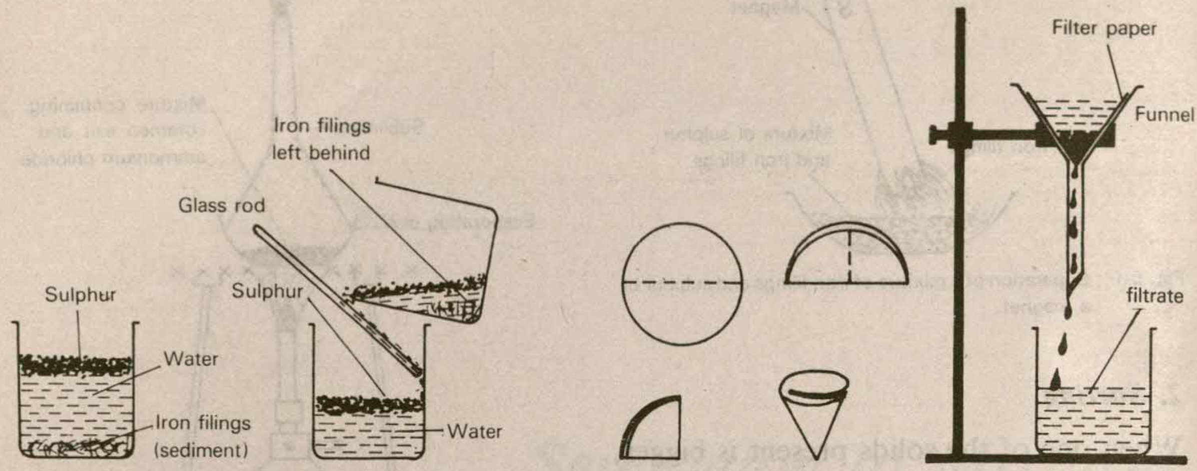
Fig. 5.2 Separation of common salt and ammonium chloride by sublimation.

5. *By Sedimentation, Decantation and Filtration*

Iron is heavier than water while sulphur is lighter than water. Both are insoluble in water. We can make use of these properties to separate a mixture of sulphur and iron filings using water.

Activity 2: Take the mixture of sulphur and iron filings in a beaker and pour water over it. Stir the water. You will find that iron filings settle down at the bottom, forming a **sediment.** The process of settling down of heavier particles in a liquid is known as **sedimentation** (Fig. 5.3a). Sulphur floats on top of the water.

Pick up the beaker and very carefully pour out the water into another beaker with



(a) Sedimentation (b) Decantation (c) Folding of a filter paper Filtration

Fig. 5.3

the help of a glass rod. Take care not to disturb the iron filings at the bottom. This process of carefully pouring out the liquids without disturbing the sediment is known as **decantation** (Fig. 5.3b).

Now the sulphur has to be separated from water. This can be done by passing the water through a sieve or a fine cloth. In the laboratory a particular kind of paper called a **filter paper** is used for this purpose. A filter paper has fine pores. Fold a filter paper twice to form a cone (Fig. 5.3c). Fit it into a funnel and wet it with a few drops of water so that the paper sticks to the funnel. Now carefully pour the sulphur and water mixture on to the filter paper. The sulphur particles remain in the filter paper. The liquid collected after passing through the filter paper is called the **filtrate** (Fig. 5.3c).

This process of separation of solid particles from a liquid by passing through a filter is called **filtration.**

The process of sedimentation, decantation and filtration is used to purify water for town supply.

6. Evaporation

Suppose one of the solids present in a mixture of two solids is soluble in water (or in any other liquid), for example salt and sand. How can we separate this mixture?

Activity 3: Take the mixture in a beaker and add water to it. Stir to dissolve salt. After sedimentation of sand, filter the solution and separate out the sand. The filtrate contains salt dissolved in water. Heat the filtrate in a china dish (Fig. 5.4). Continue heating until the water evaporates completely and dry salt is obtained.

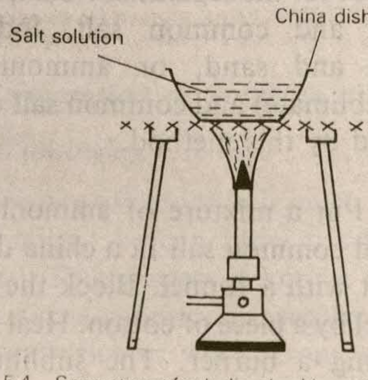


Fig. 5.4 Separation of salt dissolved in water by evaporation

Evaporation can also be done without heating but it takes a much longer time. An example is the preparation of salt from sea water. Sea water is taken in specially prepared enclosures and exposed to sunlight. It evaporates to leave behind salt.

In some cases, e.g. for separating sugar dissolved in water, evaporation cannot be done by heating, as heat causes chemical change in sugar.

7. Distillation

This method is used for separating a mixture of a solid dissolved in a liquid, when we require both the solid and the liquid to be collected. This is unlike the case of evaporation where we allow the liquid to escape. For distillation a special apparatus is used which enables us to collect the evaporated liquid through condensation (Fig. 5.5). Here again let us take the example of salt solution.

Activity 4. Put the salt solution in the flask. Evaporate the solution by heating. As the water vapour passes through the condenser, it gets cooled and condenses to water drops. These drops are collected in a beaker. When the evaporation is complete the salt is left behind in the flask, and the water is colleted in the beaker.

The solid substance left behind in the flask is called the **residue** and the liquid collected in the beaker is called the **distillate.**

The process of distillation is used for getting pure (or distilled) water from tap water for medical purposes. Rain water is also a form of nature's distilled water, as rain drop formation is a process of evaporation followed by condensation.

5.2 Separation of Mixture Containing Liquids and Gases

The methods for separation of mixtures of liquids and mixtures of gases are the same. This is because a mixture of gases is first liquified through cooling and then the components are separated.

Separation of Miscible Liquids

Liquids which diffuse into each other

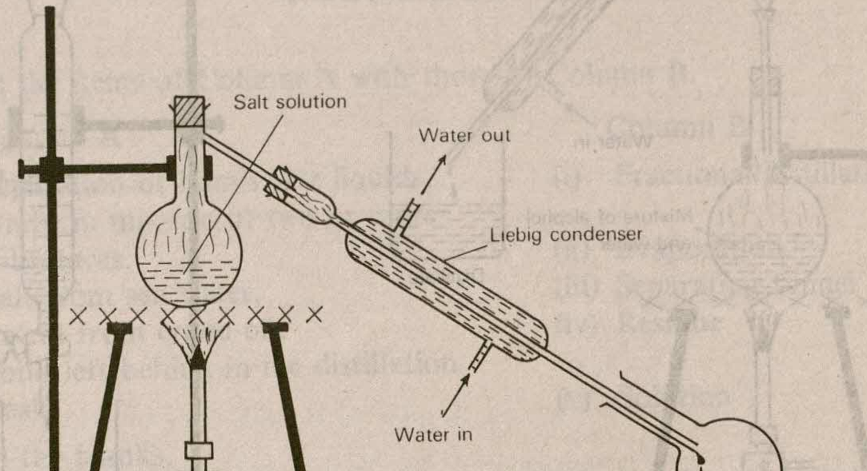


Fig. 5.5 Separation of salt and water from salt solution by distillation.

completely are called **miscible liquids**. Examples are mixtures of **alcohol** and water, ink and water, milk and water, petrol and kerosene etc. Crude oil is a mixture of a number of miscible liquids.

The process of separation of such mixtures is based on the fact that the component liquids have separate boiling points. The mixture is distilled in a normal distillation apparatus with a special attachment called **fractionating column** (Fig. 5.6). The liquid which has lower boiling point evaporates first and gets collected after condensation in a receiver. When this liquid is completely distilled out, the temperature of the solution is raised and the liquid with the next higher boiling point starts distilling. This liquid is collected in another receiver. The process is repeated until all the component liquids present in the mixture are separated out. Since the separation of the components is done in fractions, this method of distillation is called **fractional distillation.** Various petroleum products such as cooking gas, petrol, kerosene, diesel, petroleum—jelly, paraffin wax etc. are obtained from crude oil by fractional distillation.

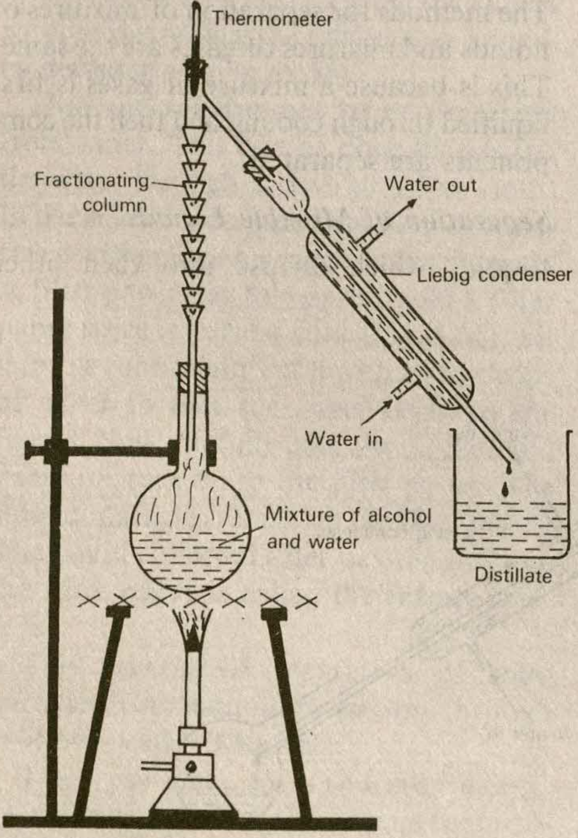


Fig. 5.6 Separation of water and alcohol by fractional distillation.

Separation of Immiscible Liquids

Liquids which do not mix with each other are called **immiscible** liquids, for example, water and oil, petrol and water, or kerosene and water. For separation of such liquid mixtures, we take advantage of the difference in their densities.

Activity 5: Take a mixture of kerosene and water in a beaker. You will notice that they form two layers with kerosene at the top,

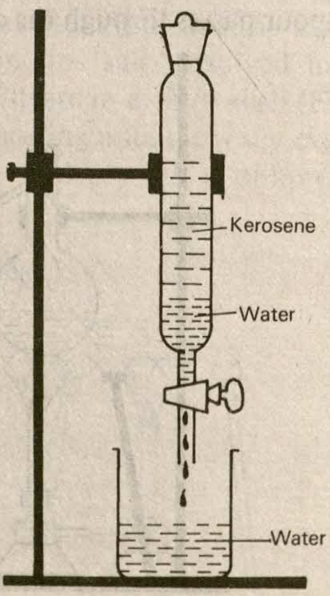


Fig. 5.7 Separation of immiscible liquids using a separating funnel.

as it is lighter than water. Pour the mixture into a separating funnel (Fig. 5.7) and allow it to settle. Open the tap and run the heavier water into a beaker. Stop the flow of water when the line dividing the two liquids reaches the hole of the tap. Change the receiver and collect the kerosene left in another receiver.

Separation of Colours and Dyes—Chromatography

For a mixture of colours and dyes, separation of components is not possible by the methods already described. For this, a special technique called **chromatography** is used.

Activity 6: A simple experiment to understand the principle of chromatography can be done by you. Prepare a mixture of red, blue and black inks. Put a drop of this on a blotting paper. After some time you will notice that each colour spreads out in separate rings (Fig. 5.8).

Different dyes are used in preparing inks of different colours. Some of these dyes stick more firmly to the fibres of a filter paper than others. The dye that sticks least goes furthest on the filter paper, and forms the outermost ring.

The different dyes can be separated by dissolving in appropriate solvents. Chromatography is also used to identify substances present in a mixture.

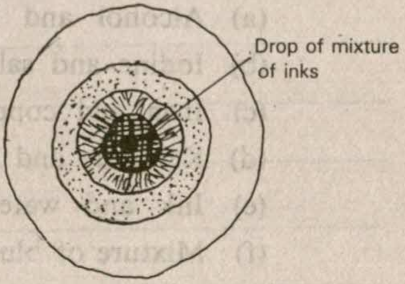


Fig. 5.8 Experiment to demonstrate the principle of chromatography.

EXERCISES

1. Match the items of Column A with those of Column B.

Column A	Column B
(a) Separation of immiscible liquids.	(i) Fractional distillation
(b) Uniform mixture of two or more substances.	(ii) Evaporation
(c) Salt from sea water.	(iii) Separating funnel
(d) Petrol from crude oil.	(iv) Residue
(e) Solid left behind in the distillation flask.	(v) Solution

2. Fill in the blanks.
   (a) The technique used to separate out colours and dyes is called________
   (b) When both the solute and the solvent are required back from a solution the method of separation to be adopted is__________________________

(c) The liquid obtained after filtration is called ________

(d) Distillation is a process which involves________ followed by ________

(e) Insoluble solid particles which are lighter than a liquid are removed from the liquid by the process of________

(f) Liquids which mix with each other are called ________

(g) The process of settling down of heavy solid particles in a liquid is called ________

3. Write against each the method you would adopt to separate out the mixtures.

(a) Alcohol and water________

(b) Iodine and salt________

(c) Iron and copper filings________

(d) Kerosene and water________

(e) Ink and water________

(f) Mixture of blue and black inks________

(g) Dust particles in milk________

4. Explain briefly how you will separate out a mixture of salt, camphor and sand.________

____

____

____

____

____

____

____

____

5. (a) A mixture contains 3 liquids A, B, and C of boiling points, 100°C, 80°C and 60°C respectively. If the mixture is fractionally distilled, which of them would distil out first and which one the last? ________

____

(b) Air is a mixture of gases. Name the process by which you can obtain the components of air.

(c) Name the processes by which river water, which is a mixture, is converted to clean water for town supply.

6. What type of mixture would you separate by the following processes. Give one example in each case.

(a) Winnowing

(b) Sorting

(c) Using a magnet

(d) Sublimation

(e) Sedimentation and decantation

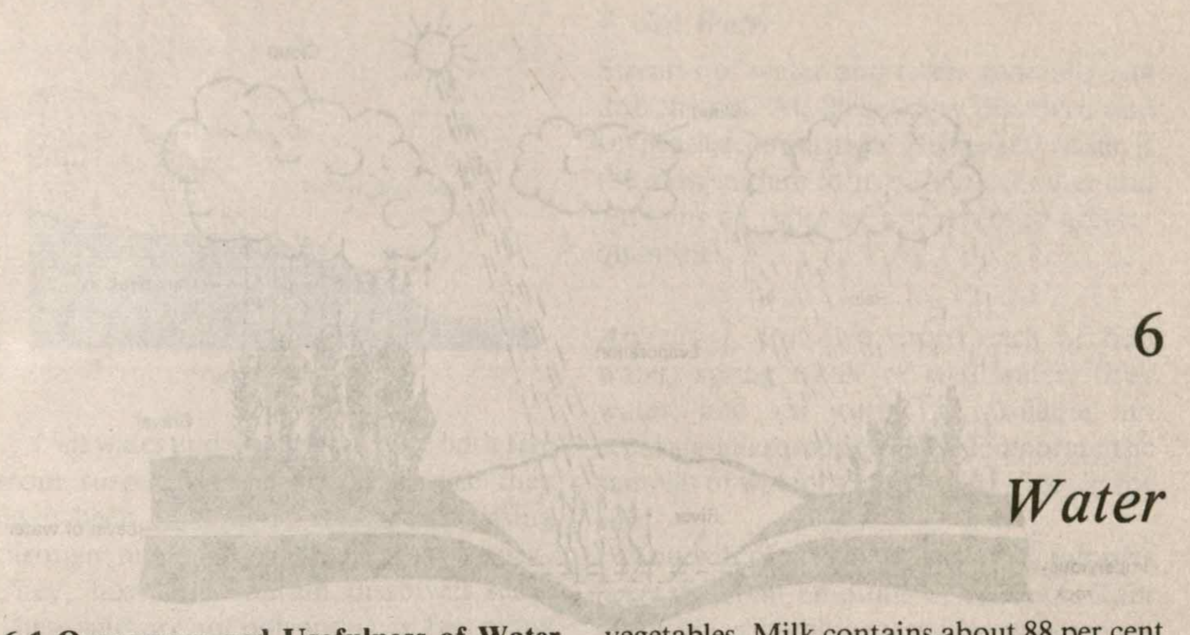
(f) Filtration

(g) Distillation

(h) Fractional distillation

(i) Chromatography

(j) Separating funnel



6

Water

6.1 Occurrence and Usefulness of Water

Water is the most widely distributed liquid on the earth. About 70 per cent of the earth's surface is covered with water of lakes, rivers, seas and oceans. Water is present as vapour in the air and as clouds in the upper atmosphere.

Water is essential for the existence of both living beings and plants. The soil contains large quantities of water which helps in the growth of plants. Without water all human beings and animals would die of thirst. It is essential for cooking and washing. Rivers, seas and oceans are being used for transportation of goods and men. Dams constructed on rivers help in the generation of electricity.

All living organisms contain water. Blood contains a lot of water. Many chemical reactions in living organisms, such as digestion of food, need the presence of water. Our food contains a large quantity of water, from 3 to 4 per cent in dry cereals such as maize and wheat, to about 90 per cent in tomatoes and fresh green vegetables. Milk contains about 88 per cent of water. In fact, our body contains nearly 65 per cent of water. It is impossible to imagine life without water.

6.2 The Water Cycle

The circulation of water from the earth's surface to the atmosphere and back to the earth is called the **water cycle** (Fig. 6.1). Water is constantly going into the atmosphere by evaporation from oceans, seas, rivers and lakes. Plants give out large amount of water vapour during *transpiration*. The water vapour settles on dust particles in the air and forms drops of water which collect together to form clouds. When water drops in the cloud become too heavy they fall down as rain water, snow and hail.

Air is thus a great storehouse of water vapour. Attempts are being made by scientists to utilise the water vapour in the air to create artificial rain which will be helpful in times of drought.

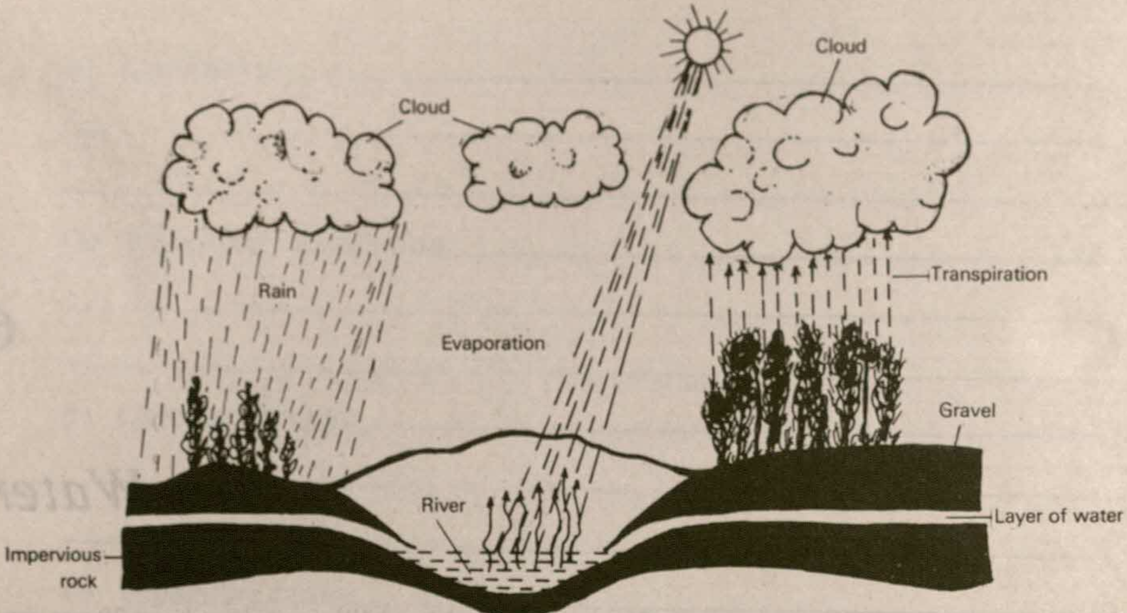


Fig. 6.1 The water cycle

6.3 Water in Nature

In nature, water occurs mainly in the following forms.

1. Rain Water

Rain water is the purest form of water in nature. When water evaporates from the surface of oceans, lakes and rivers, it leaves behind dissolved compounds. The water in the clouds which falls as rain water is, therefore, free from soluble impurities and is naturally occurring **distilled water.** However, it dissolves a little of oxygen and nitrogen and a fair amount of carbon dioxide present in the air. Carbon dioxide forms carbonic acid with rain water.

carbon dioxide + water → carbonic acid

If few drops of rain water are evaporated, no residue is left behind except a few dust particles.

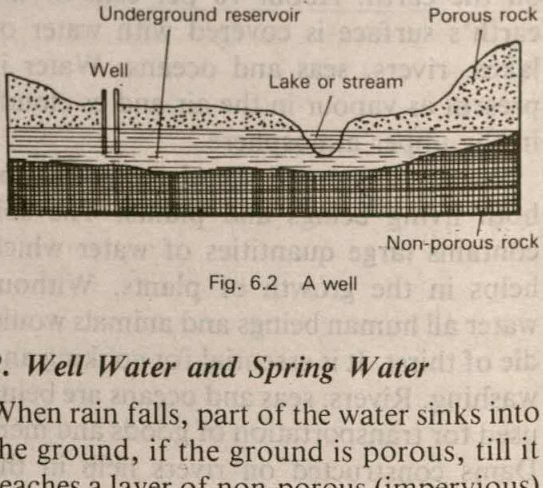


Fig. 6.2 A well

2. Well Water and Spring Water

When rain falls, part of the water sinks into the ground, if the ground is porous, till it reaches a layer of non-porous (impervious) rock. Here it gathers and forms a **reservoir**. If we dig deep enough, we can reach this underground water; thus a well is formed (Fig. 6.2).

The rain water may also run along the surface of the non-porous rock and come out on the surface elsewhere as spring water (Fig. 6.3).

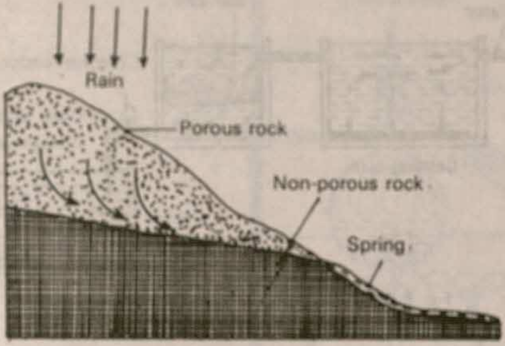


Fig. 6.3 A spring

Well water and spring water are both free from suspended impurities because they have been filtered by nature in passing through many layers of sand and rock. They, however, contain dissolved salts. These salts are not poisonous; in fact many of these have medicinal values.

3. River Water

A part of the rain water forms streams of water which move from higher to lower places. Many such streams join together to form a large stream called **river.**

In high mountains the water vapour present in the atmosphere condenses to form ice due to low temperature. The layer of ice becomes very thick in due course of time and the ice at the bottom of the layer melts due to high pressure of the layer above (an unusual property of ice). Ice also melts into water during the summers. Water formed by these methods gives rise to a river. The river Ganga and many other rivers in the world are formed in this way. These rivers are **perennial.**

4. Sea Water

Streams of water and rivers generally run into the sea. All these carry dissolved and suspended impurities. Hence sea water is the most impure form of natural water and contains all types of impurities in greater quantities.

Activity 1: Put two drops each of rain water, spring water or well water, river water, and sea water, if available, on separate microscope slides. Evaporate the samples of water by putting the slides in the sun.

You will observe that different samples leave different amounts of residues. Rain water leaves hardly any residue whereas sea water leaves the maximum residue (Fig. 6.4).

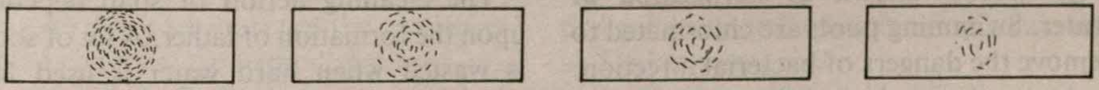
6.4 Town Water Supply

A large number of towns in India are located on the banks of rivers. They get their water supply from rivers. Before the water is fit for drinking it must be freed from (a) suspended impurities and (b) harmful living objects.

The following purification methods are employed.

1. Sedimentation

Water is allowed to flow through a number of settling tanks where bigger particles settle at the bottom of the tanks. This is called **sedimentation.** A mixture of lime



Sea water River water Spring or well water Rain water

Fig. 6.4 Residue left after evaporation of various types of waters.

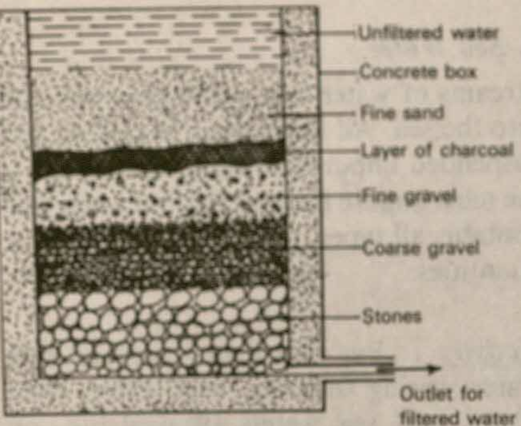


Fig. 6.5 Filter bed

and alum is added to precipitate fine particles of clay.

2. Filtration

Any suspended impurity is removed by passing through a filter bed consisting of layers of fine sand, charcoal, gravel and stones (Fig. 6.5).

3. Treatment against Living Organisms

Very often the water we obtain from rivers contain bacteria, algae, protozoa, roundworms and eggs of living organisms such as mosquitoes. These are harmful to man because they cause dangerous diseases such as cholera, dysentery and typhoid. The filtered water is treated with **chlorine gas** which destroys the harmful living organisms. Small quantities of water at home can be made safe for drinking by boiling for about 15 minutes which kills all the disease organisms. Removal of these organisms is known as **sterilisation of water**. Swimming pools are chlorinated to remove the dangers of bacterial infection. In some advanced countries ozone is used to kill the harmful germs.

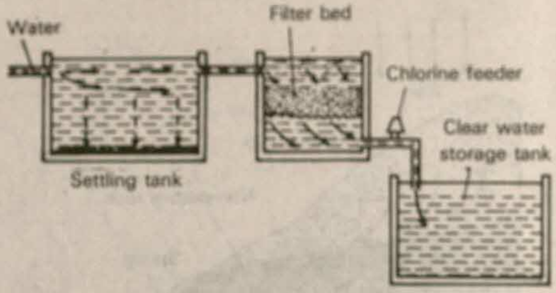


Fig. 6.6 Purification of water for town supply

Different stages in the purification of town supply water have been shown in Fig. 6.6.

6.5 Hard and Soft Water

The nature of water differs from place to place. Some samples of water produce lather easily with soap and some samples of water produce lather with difficulty. *Water, usually from a spring or a well, which does not lather easily with soap, is said to be* **hard water.** Hard water contains soluble salts of calcium and magnesium. *Distilled water and rain water, which lather easily with soap, are said to be* **soft water.**

There are two types of hardness in water—**temporary** and **permanent.** Temporary hardness can be removed easily by boiling followed by filtration. Permanent hardness cannot be removed easily and needs special chemical treatment. Addition of small amounts of lime also removes temporary hardness. If you add washing soda to water and filter it, both temporary and permanent hardness can be removed.

The cleaning action of soap depends upon the formation of lather. A lot of soap is wasted when hard water is used for washing clothes. When hard water is boiled in boilers and electric kettles, salts of

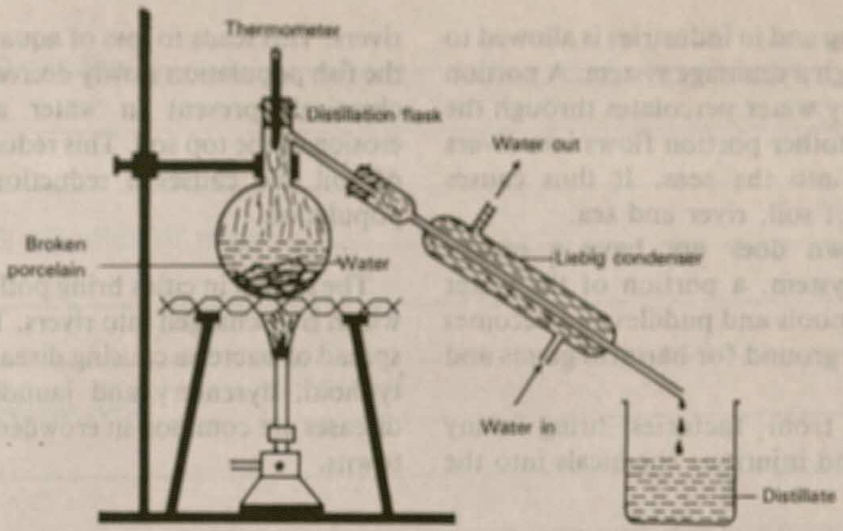


Fig. 6.7 Preparation of distilled water

calcium and magnesium present in the water are deposited in them. This deposit is called 'fur' or 'scale'. It reduces the efficiency of the boilers and kettles.

The water which we drink must have a certain degree of hardness. The calcium salts present in water help in the formation of strong bones and teeth. Water is carried to our homes in lead pipes. Soft water dissolves lead and causes lead poisoning. Hard water does not dissolve lead.

6.6 Distilled Water

The apparatus used for obtaining pure water from impure water is called **distillation** apparatus. The impure water is placed in a **distillation flask** and boiled. The steam produced is allowed to pass through the inner tube of a **Liebig condenser.** A stream of cold water is made to flow through the outer jacket of the condenser. Steam condenses to form droplets of pure water, called **distilled water,** which is collected in a receiver. *The process of changing a liquid by heating into vapour and then changing the vapour back to liquid by cooling is called* **distillation.** The liquid collected in the receiver by distillation is called the **distillate.** Broken pieces of porcelain are often added to the water to avoid bumping.

6.7 Pollution of Water

We live with others, animals and plants, in our environment. All human beings, animals and plants share air, soil and water in a particular locality. If any undesirable substance is present in our environment in excess of that which should be normally present, the environment is disturbed. We then say that the environment has been polluted.

Polluted water contains some foreign matter which degrades its quality and makes it less suitable for drinking, domestic and other purposes.

Water gets polluted in different ways. The water we use in our homes for cleaning and washing and in industries is allowed to flow through a drainage system. A portion of this dirty water percolates through the soil and another portion flows into rivers and then into the seas. It thus causes pollution of soil, river and sea.

If a town does not have a proper drainage system, a portion of the water may form pools and puddles and becomes a breeding ground for harmful germs and insects.

Wastes from factories bring many harmful and injurious chemicals into the rivers. This leads to loss of aquatic life and the fish population slowly decreases. These chemicals present in water also cause erosion of the top soil. This reduces fertility of soil and causes a reduction in plant population.

The sewers in cities bring polluted water which is discharged into rivers. This causes spread of bacteria causing diseases such as typhoid, dysentery and jaundice. These diseases are common in crowded industrial towns.

EXERCISES

1. Explain the following giving reasons.

(a) Rain water is as good as distilled water. ____________________

____

____

(b) Well water is a better water for drinking purposes than river water. ______

____

____

____

(c) Sea water is tne most impure form of natural water. ____________________

____

____

2. Define the terms given below:

(a) Sedimentation ____________________

____

____

(b) Distillation ____

____

____

(c) Sterilisation of water ____

____

____

(d) Water cycle ____

____

____

3. Complete the following statements by filling in the blanks

(a) Chlorine is added to water for____________ the ____________ present in water.

(b) The chemicals present in river water help in the ____________ of top ____________

(c) The industrial wastes in river water leads to loss of____________

4. Which of the following statements are true and which are false. Write T for true statements and F for false statements.

(a) Hard water is not fit for drinking.
(b) Hard water causes wastage of soap used for washing clothes.
(c) Spring water is not fit for drinking.
(d) Permanent hardness in water can be removed by boiling.

5. (a) What do you understand by hardness of water and how is hardness caused in water?____

____

____

____

(b) How can you remove temporary hardness in water?____________

____

(c) How can you remove both temporary and permanent hardness in water? ____

6. (a) What are the disadvantages of hard water? ____

(b) What are the advantages of hardness in water? ____

7. (a) Mention three ways by which river water is polluted. ____

(b) Mention three harmful effects of polluted water. ____

7

The Air around Us

The Earth is surrounded by a layer of air, called the **atmoshpere,** which extends to a height (altitude) of about 80 kilometres. Although it cannot be seen, its presence is felt when wind blows. Kites and birds fly as high as air takes them and the movement of clouds is directed by the air.

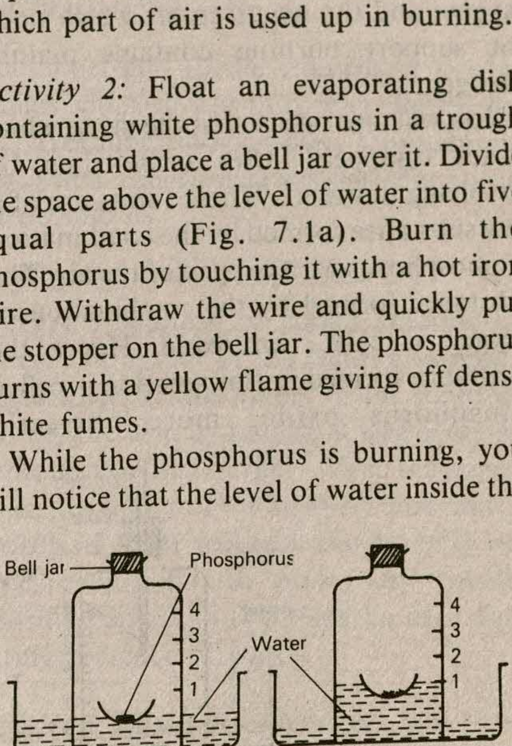
A very important use of air to us is in breathing. Without air we cannot survive for more than a few minutes. There is no air on the moon and astronauts have to carry their own supply of air when they land on the moon. Mountaineers, when they climb Mt. Everest, have to carry their supply of air because at a high altitude the supply of air is not sufficient for normal life. Air dissolved in water is essential for the survival of fish. Man-made satellites must be made to orbit at altitudes of over 300 km so that they are not slowed down or burnt out by too much friction with air.

7.1 Burning in Air

Activity 1: Light a candle and place it on the table. Cover it with a jar. You will notice that it blows out within a few minutes. Thus burning of any substance requires the presence of air. Let us study which part of air is used up in burning.

Activity 2: Float an evaporating dish containing white phosphorus in a trough of water and place a bell jar over it. Divide the space above the level of water into five equal parts (Fig. 7.1a). Burn the phosphorus by touching it with a hot iron wire. Withdraw the wire and quickly put the stopper on the bell jar. The phosphorus burns with a yellow flame giving off dense white fumes.

While the phosphorus is burning, you will notice that the level of water inside the



(a) Before burning (b) After burning

Fig. 7.1 Oxygen is used up in burning

bell jar goes down slightly. The heat produced by burning of phoshorus causes expansion of air, and hence the level of water falls in the beginning.

After some time phosphorus stops burning. When the gases inside the jar cool down, the level of water inside the jar rises up to the first mark (Fig. 7.1b). Thus one-fifth of the air has been used up in burning. It is this part of the air which supports burning of substances in air. Water takes its place.

Remove the stopper of the bell jar and quickly introduce a lighted splint into it. The splint is extinguished. This shows that the remaining four-fifths of the air does not support burning. Air, therefore, contains at least two gases. The active part of the air which supports burning is called **oxygen**; and the inactive part which does not support burning contains mainly **nitrogen**.

You will also notice that the dense white fumes disappear after some time by dissolving in water. These fumes are of a new substance formed by the combination of phosphorus with oxygen of the air. The substance formed by the combination of oxygen is called an **oxide**. Hence the substance formed in this reaction is called phosphorus oxide, more correctly phosphorus pentoxide. The word equation is given below.

phosphorus + oxygen → phosphorus pentoxide

7.2 Burning of Magnesium in Air

Activity 3: Place a bell jar in a trough containing water. Mark off the space above the level of water into five equal parts. Tie a magnesium ribbon to an iron wire and light it. Quickly introduce the burning ribbon into the bell jar and tighten the cork. You will notice that magnesium burns with a blinding white light and forms a white ash, while the level of water rises to the first mark. The gas left over does not support burning (Fig. 7.2).

Like phosphorus, magnesium also combines with the active part of air called oxygen, leaving four-fifths which is inactive and is mainly nitrogen. The white ash is the new substance formed by the combination of magnesium with the oxygen of the air and is called magnesium oxide. The word equation for the reaction is

magnesium + oxygen → magnesium oxide

Similar experiments with other substances show that when substances burn in air they react with the oxygen part.

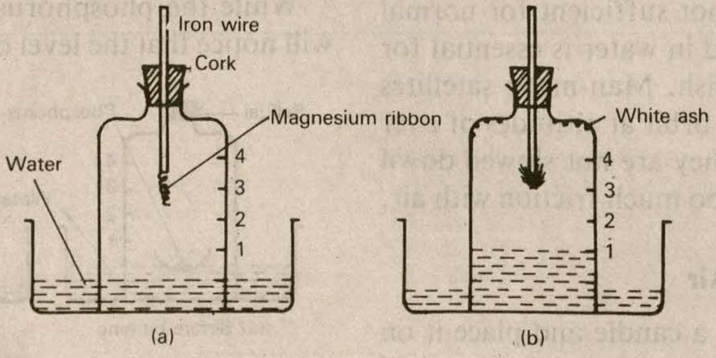
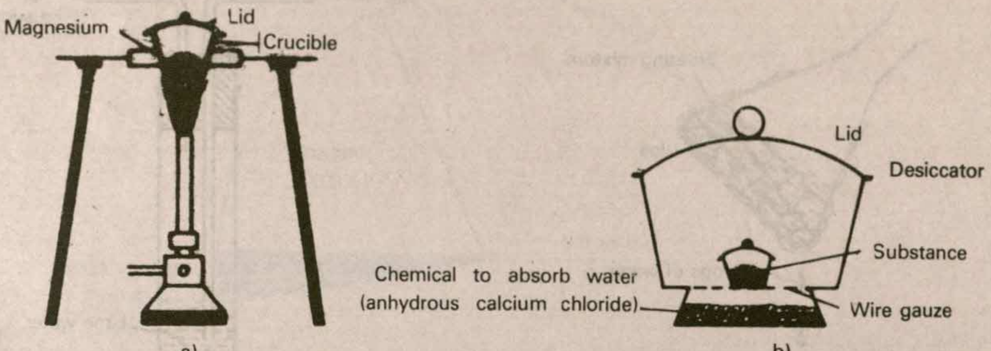


Fig. 7.2 Burning of magnesium in air



a) b)

Fig. 7.3 Magnesium increases in mass on burning

7.3 Change of Mass During Burning

Activity 4: Weigh a clean and dry crucible with the lid. Put about 10 cm long folded magnesium ribbon in the crucible, cover it with the lid and weigh again. Remove the lid and heat the crucible strongly. As soon as the ribbon begins to burn, cover the crucible with the lid (Fig. 7.3a).

Raise the lid slightly so as to allow the air to enter; but make sure that the white particles of magnesium oxide do not go out of the crucible. Cover the crucible with the lid and cool it in a **desiccator** (Fig. 7.3b). This is to avoid any water vapour from the air condensing on the crucible. Weigh the crucible containing magnesium oxide with the lid. You have taken the following three weights.

Mass of crucible with lid = a g (say)
Mass of crucible, lid and magnesium = b g
Mass of crucible, lid and magnesium oxide = c g
Hence, mass of magnesium = $(b-a)$g
and mass of magnesium oxide = $(c-a)$g

You will notice that the magnesium oxide weighs more than the magnesium. The increase in mass is due to the mass of oxygen of the air which has combined with magnesium. Hence oxygen, and therefore air, has mass.

The products of burning in air contain a greater amount of matter than the original substance.

7.4 Water Vapour in Air

The upper part of the atmosphere carries clouds which give us rain. Wet clothes dry due to evaporation of water. This suggests that water vapour is always present in the air around us.

Testing the Presence of Water

Prepare a solution of cobalt chloride in water. The colour of the solution is pink. Dip a strip of filter paper in the solution and dry the strip by keeping it well over the flame of a bunsen burner. When the paper dries, the colour of the strip becomes blue. A drop of water will turn the dry strip of paper from blue to pink. Dry cobalt chloride paper can therefore be used for testing presence of water.

Activity 5: Mix a few pieces of ice with a small amount of common salt. This is called **freezing mixture** and has a temperature lower than that of pure ice. Fill

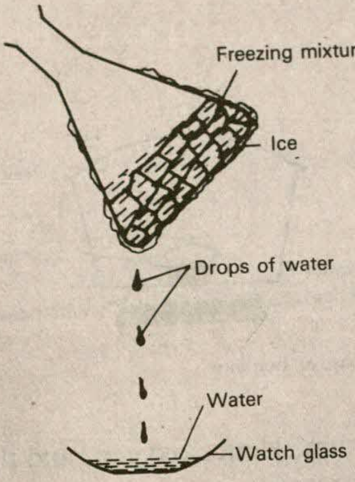


Fig. 7.4 Air contains water vapour

a conical flask with the mixture. Allow it to stand for about 20 minutes.

You will notice that the flask gets covered with small drops of water which freeze to ice. Some of the drops drip and can be collected in a watch glass (Fig. 7.4). It can be confirmed that these are drops of water by testing them with dry cobalt chloride paper. They change the colour of the paper from blue to pink.

Clouds and fog consist of small droplets of water condensing on dust particles present in air.

7.5 Carbon Dioxide in Air

Activity 6: Carbon dioxide is present in air in a very small quantity. It is formed by the combustion of fuels such as coal, coke, petrol etc. Animals breathe out carbon dioxide as a waste product.

The presence of carbon dioxide in air can be shown by bubbling air through lime water for some time (Fig 7.5).

The lime water turns milky showing the presence of carbon dioxide in air. The carbon dioxide content of air is about 0.03% by volume.

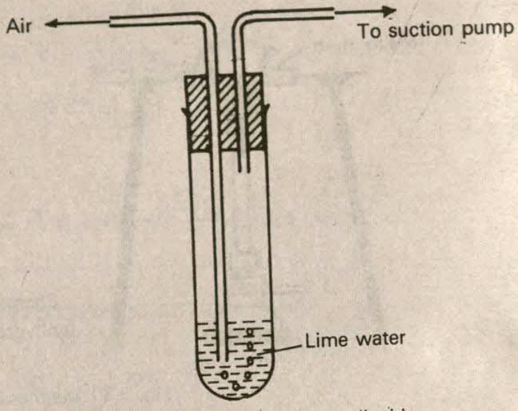


Fig. 7.5 Air contains carbon dioxide

7.6 Noble Gases

Besides oxygen, nitrogen, carbon dioxide and water vapour, there are other gases present in small quantities in the air around us. These are called **noble** or **inert** gases. They are helium, neon, argon, krypton and xenon. There is another noble gas called radon obtained by the decomposition of radium. These gases are very inactive and they hardly react with other chemicals.

Careful measurements show that the approximate composition of air, by volume, is as follows (Fig. 7.6).

Nitrogen	78.1%
Oxygen	20.9%
Carbon dioxide	0.03%
Noble gases	0.95%

Water vapour and impurities are present in small amounts.

The composition of air is generally the same in the atmosphere near the surface of the earth.

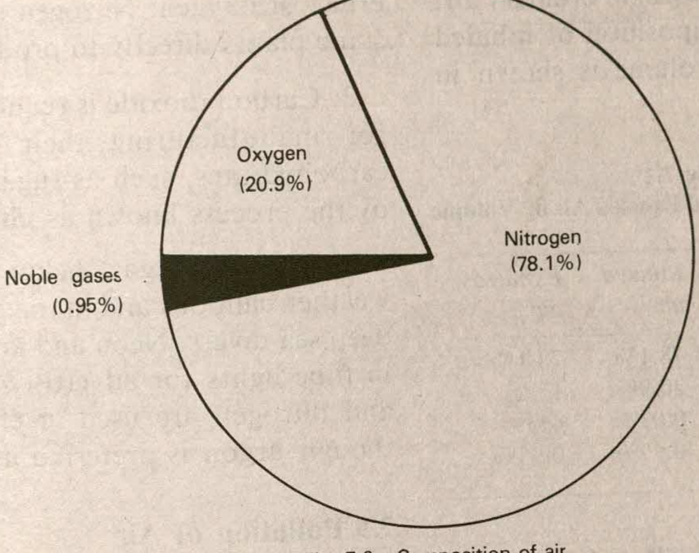


Fig. 7.6 Composition of air

The percentage of water vapour, however, varies considerably from place to place. Nitrogen, the most abundant of all the gases, is quite unreactive.

7.7 Carbon Dioxide in Exhaled Air

Activity 7: Take some lime water in two bottles fitted with rubber stoppers. These are fitted to an apparatus shown in Fig. 7.7.

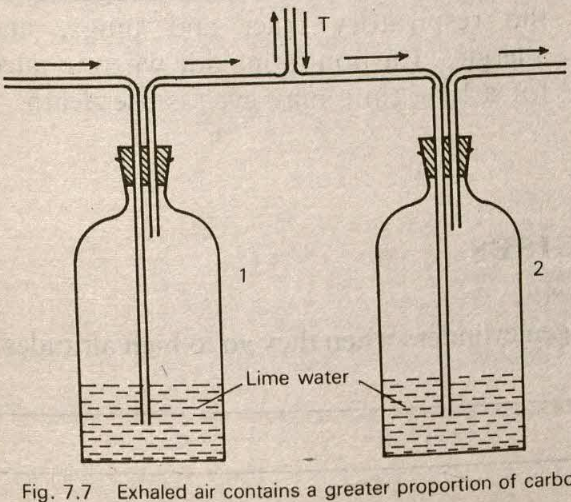


Fig. 7.7 Exhaled air contains a greater proportion of carbon dioxide than inhaled air.

If you suck in air through the tube T, the air enters through Bottle 1 and when you breathe out, the air goes out through Bottle 2. Now suck in and breathe out a few times.

You will observe that the lime water through which the exhaled air is passed forms a milky suspension. This is due to carbon dioxide.

As we have already seen, some carbon dioxide is also present in the air we inhale. However, it is present in such a small quantity that the lime water in Bottle 1 will become milky only when air is sucked in for almost half an hour.

A small portion of oxygen (about 4%) in the inhaled air is used by us to oxidise food. The slow oxidation of food produces heat energy which keeps our body warm and is used for muscular activities. The energy liberated in the oxidation of food does not, however, produce high temperature and light which are associated with burning. The exhaled gases contain about 17 per cent of oxygen as compared to about 21 per cent present in ordinary air. The approximate composition of inhaled and exhaled air by volume is shown in Table 7.1.

Table 7.1
Composition of Inhaled and Exhaled Air by Volume

	Inhaled air	*Exhaled air*
Nitrogen	78.1%	78.1%
Oxygen	20.9%	17%
Carbon dioxide	0.03%	4%
Noble gases	0.95%	0.95%

7.8 Uses of Gases in Air other than Oxygen

1. The composition of air is generally the same in the atmosphere everywhere near the surface of the earth. The percentage of water vapour, however, varies considerably from place to place and from time to time. It provides moisture for the growth of plants, controls the climatic conditions and the moisture content of the body.

2. Nitrogen, the most abundant of all gases, is quite non-reactive. One advantage of nitrogen is, however, quite clear. If the air contained mostly oxygen, even small fires would turn into huge explosions and cause great damage. Thus it dilutes the effect of oxygen. Nitrogen is taken in by some plants directly to produce proteins.

3. Carbon dioxide is required by plants for manufacturing their food called carbohydrates, such as sugar and starch, by the process known as **photosynthesis.**

4. The noble gas, helium, is used in weather balloons and in the gases used by deep sea divers. Neon and argon are used in tube lights for advertisements. Argon and nitrogen are used in electric bulbs, though argon is preferred nowadays.

7.9 Pollution of Air

Besides water vapour, other impurities present in air are harmful. Burning of coal produces harmful gases such as carbon monoxide, sulphur dioxide and hydrogen sulphide. It also produces large quantities of unburnt carbon, tarry matter and fine dust particles. These settle down on plants and retard their growth. Incomplete combustion of petrol and diesel in engines also produces carbon monoxide. When inhaled with air, all these impurities cause respiratory disorders such as congestion in the respiratory tract and lungs, and allergies. Carbon monoxide when inhaled for a long time may even cause death.

EXERCISES

1. (a) Why do mountaineers carry oxygen cylinders when they go to high altitudes?

____

____

____

(b) What is the importance of air dissolved in water? ______________

____

____

(c) Why do satellites orbit approximately 300 km above the earth's surface? ______________

____

____

2. When phosphorus is burnt in a trough and covered with a bell jar, some of the observational changes taking place are as given below. Explain each of the observation.

(a) The level of water goes down first. ______________

____

____

(b) It rises finally to 1/5 of the space above the level of water. ______________

____

____

____

(c) White fumes are seen in the beginning. ______________

____

____

(d) The white fumes gradually disappear. ______________

____

____

3. (a) A given mass of coke is burnt in a closed space. The gases formed and the residue left are all weighed. Will there be an increase or a decrease in mass as compared to the coke initially taken? Why? ______________

____

____

____

(b) Why are chemicals sometimes put in a desiccator?

4. Fill in the blanks in the sentences below.
   - (a) When elements burn in air, they generally combine with ________ of the air, and form their ________
   - (b) Helium, neon, argon are called noble gases because they are ________ elements.
   - (c) Nitrogen from the air is taken by some plants to produce ________
   - (d) Plants take in carbon dioxide of the air to give ________
   - (e) Magnesium burns in air to form ________

5. (a) How will you detect the presence of carbon dioxide in air?

   (b) How will you find out if a given sample of a colourless liquid contains water?

   (c) Name three substances which cause pollution of air.

6. (a) Give the approximate composition of air by volume.

   (b) What is the function of nitrogen in air?

7. (a) What is the difference between inhaled and exhaled air?

(b) How will you distinguish between oxygen and carbon dioxide? ____________

____

____

(c) A white crystalline solid is heated in a test tube, a colourless liquid is deposited on the upper part of the test tube. This liquid is put on a paper coated with a substance Y which turns from blue to pink.

(i) Name the colourless liquid ____________________

(ii) Name the substance Y ____________________

Understanding Science

Physics - Classes 6, 7 & 8
Chemistry - Classes 6, 7 & 8
Biology - Classes 6, 7 & 8

This series of nine books is planned according to the guidelines set by the NCERT, but caters to the needs of the ICSE syllabus as well. The approach is modern, yet simple. The important concepts, scientific terms and definitions have been highlighted to help the student to remember them easily. Concepts have been formed with the aid of innovative experiments so that learning becomes an enjoyable experience rather than a tedious ritual. The students can perform the experiments on their own with readily available apparatus. Each chapter has an extensive workbook section containing mainly short-answer and objective type questions.

Sangam Books

Koshy, Varma & Srivatsan : UNDERSTANDING SCIENCE CHEMISTRY Class VI
ISBN 0 86131 650 9
Rs. 10.50